GAS

JUNE 1961

A CHILTON PUBLICATION

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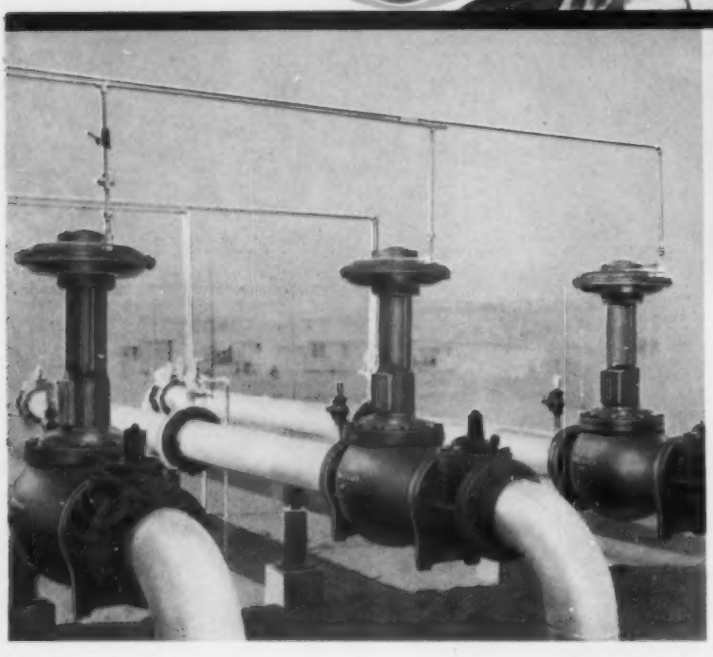

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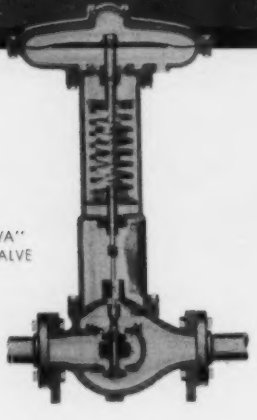

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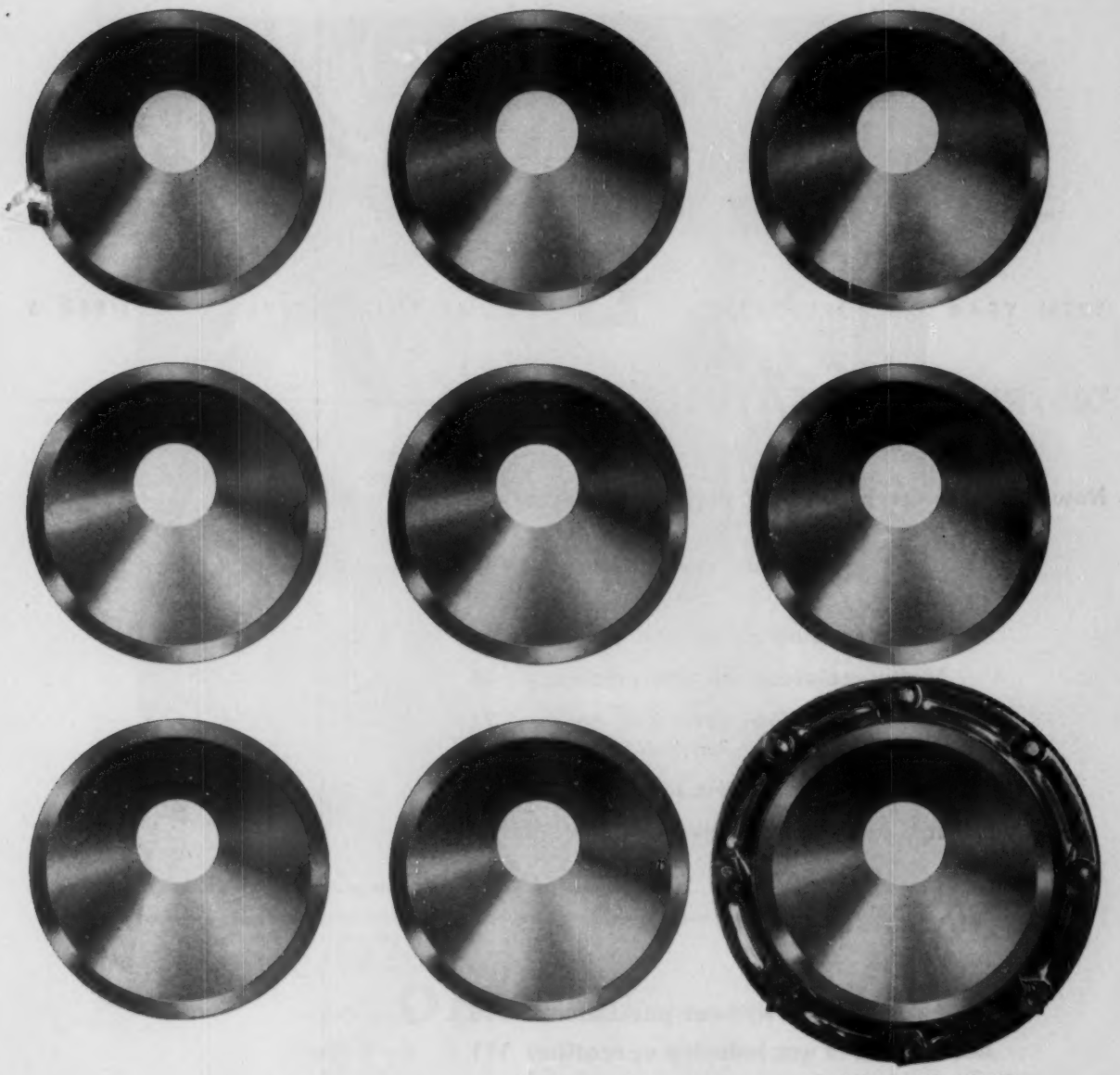

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CONTENTS

JUNE 1961

37TH YEAR OF PUBLICATION

VOLUME THIRTY-SEVEN • NUMBER 6

DISTRIBUTION FEATURES

New program for high-speed digital computer 55 *A. G. Prasil and R. V. Jebavy*

Periodic meter changing 61 *Albert D. Petersen*
Part 2—Evolution in Trucks

Wrapping mains and services 66 *J. R. Grey*

Meter maintenance and efficiency 68 *R. C. Turner*

Gas refresher course 71 *Irving Deutsch*
Part 2—What is gas?

Thermoplastic pipe bonding 75 *A. H. Silver*

GAS abstracts papers on heating and cooling 77

PIPELINE FEATURES

Engines without pushbuttons 105 *Bland Osborn*

Automation in gas industry operations 111 *Ken Kridner*
—Part 3

A report on AGA's line pipe seminar 117 *Ken Kridner*

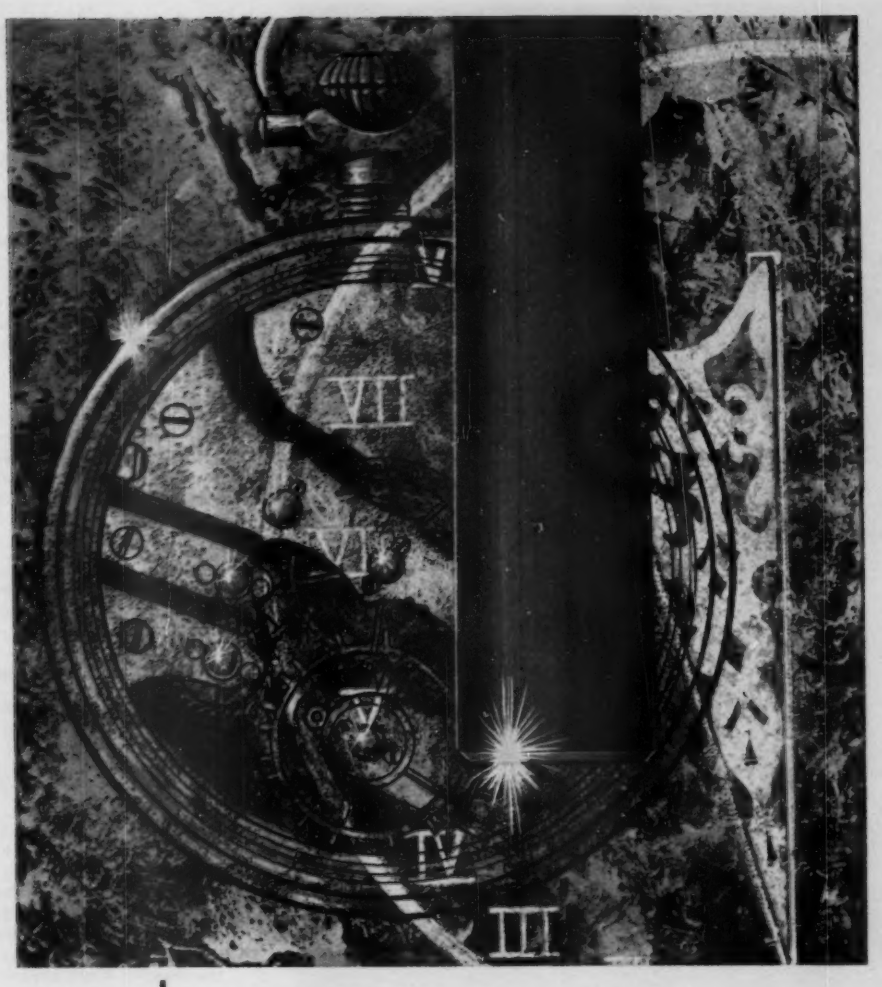
DEPARTMENTS

Editorial Comment—

Thermally Thinking—*J. Fred Ebdon* 6
Highlights 8
Regulatory Trends 11
Technical Trends—*Guy Corfield* 15
Washington—*Neil Regeimbal* 17
Corrosion—*Marshall E. Parker* 23
The Gassing Game—*Jim Clark* 25
Management, Automation, Control—*Ken Kridner* 125
Communications, Tele-Control—*Vinton Long* 127

Departments—

Calendar 5
Distribution News 81
Products & Trade Literature 82
Convention Coverage 96
Pipeline News 128
People 138
Pipeline People 144
Advertisers Index 158



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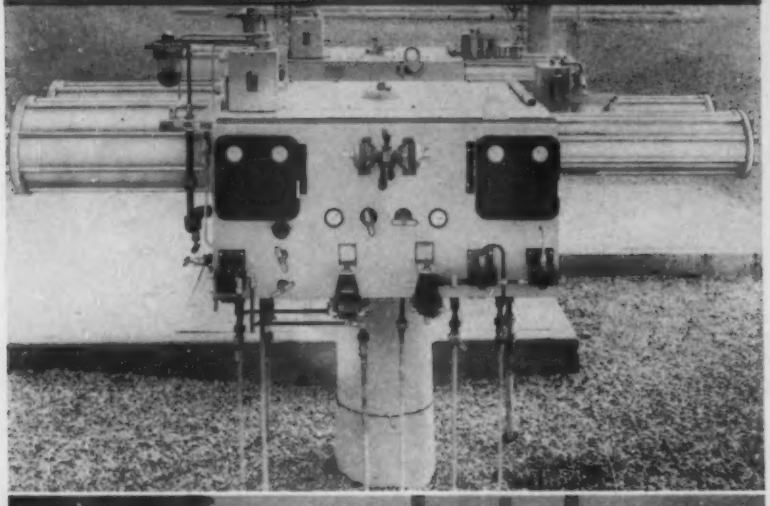

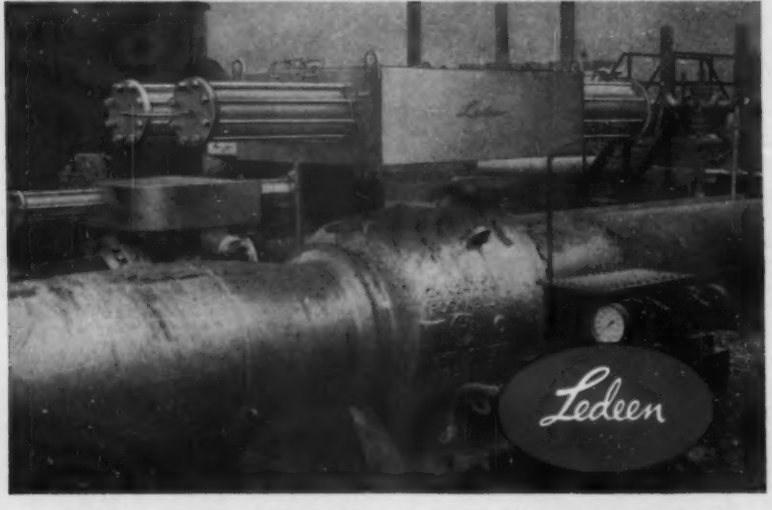

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BPA NBP

CALENDAR

June

5-6..AGA Eastern Regional Gas Sales Conference — Pittsburgh Hilton Hotel, Pittsburgh, Pa.

6-8..ISA Summer Instrument-Automation Conference & Exhibit—Royal York Hotel, Toronto, Ont., Canada.

6-8..6th Annual Appalachian Underground Corrosion Short Course—West Virginia University, Morgantown, W. Va.

13-14..National Safety Council's Public Utilities Section, Executive Committee—Laurentian Hotel, Montreal, Quebec, Canada.

13-16..3rd Biennial International Gas Chromatography Symposium — Kellogg Center, Michigan State University, East Lansing, Mich.

20..NEGA Operating Division — Worcester Polytechnic Institute, Worcester, Mass.

20-24..Canadian Gas Association Annual Meeting—Banff Springs, Alberta.

21-23..NEGA Measurement, Control & Corrosion School — Worcester Polytechnic Institute, Worcester, Mass.

26-27..Michigan Gas Association Annual Meeting—Grand Hotel, Mackinac Island, Mich.

28..8th International Gas Conference—Stockholm, Sweden.

September

11-13..AGA Annual Accident Prevention Conference—Statler Hilton Hotel, Dallas.

12-14..Mid-West Gas Association School and Conference—Ames, Iowa.

13-15..Pacific Coast Gas Association Annual Convention—Coronado Hotel, Coronado, Calif.

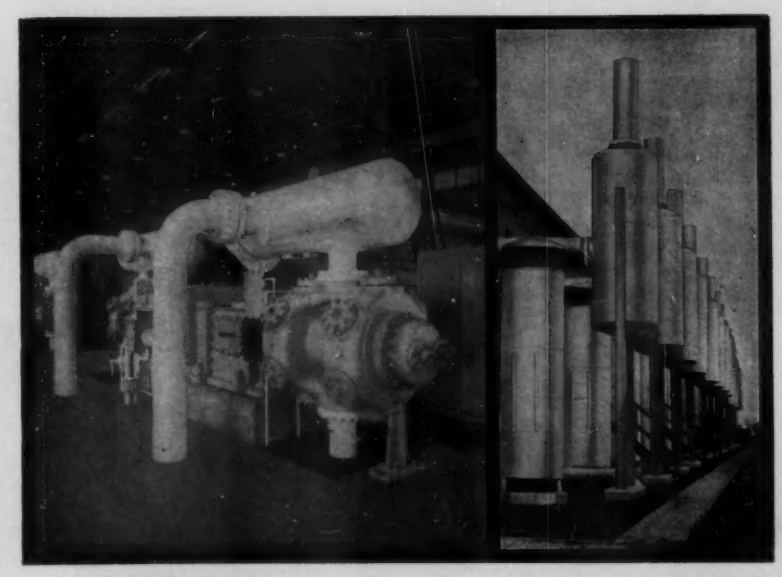
18-19..Independent Natural Gas Association of America Annual Meeting—Shamrock Hilton Hotel, Houston.

October

1-4..American Gas Association Annual Convention—Dallas

3-4..Ninth Annual Gas Measurement Institute (University of Kansas)—National Guard Armory, Liberal, Kans.

12-13..California Natural Gasoline Association 36th Annual Fall Meeting — Lafayette Hotel, Long Beach, Calif.



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GAS

JUNE 1961

Thermally Thinking

M-A-C column debuts

WE have been contentedly laboring under the impression that the world was round. Recently, however, a multi-million dollar chunk of electronics and cryogenic plumbing beeped back from out in space that the thing is actually kinda' ellipsoidal. This simply proves that one has to change his thinking every now and then.

Some people are able to make changes; others are not. You can still find people sitting around snapping their sleeve garters and remarking on the wonderful world of "the good old days." From what I can learn, those "good old days" were pretty miserable. But many still wish that times hadn't changed. Such people got on the whittle-and-spit circuit at a tender age and never bothered to get off.

Fact of the matter is that everything changes. And most of us feel that change is good, for it usually means progress. The only exception to this I can think of off hand is in regulation of the gas industry. There, it seems as if every change has a retrograde effect.

Certainly the gas industry has changed. Nearly gone is the sooty enchantment of gas-plant generator, carburetor, and wash box. Gone too are the rubber inner-tube "repair" of a leaking main; the squirts of alcohol in a wet-type meter—one for the meter and one for the "technicians"; the pile of horse manure over a farm-tap regulator (for prevention of hydrate formation); the use of a match to find a gas leak; and many other classical things of the gas industry.

Now, before anyone writes me to say his company still uses some classic "techniques," may I say "kindly don't"—I'm just not interested.

We try to stay poised for change. Believe me, in the publications-advertising field, this is the only way you can make it. You just can't let changes bother you.

Well, there are some fast changes coming in the gas industry. Many of them will involve electronics. Many of them will not. But in concert they will add up to this thing called automation. It will bring vast changes.

One of the very prime fields for automation is in gas measurement. Not that gas measurement men will resist the automated concept any harder than some others in the gas industry; they'll just resist it longer. Why? Because gas measurement is a sorely neglected part of gas company operations. The neglect I refer to is specifically placed on the shoulders of management.

Gas industry management in general just seems to take gas measurement science and application for granted. In turn, measurement personnel evolve to the same attitude since what's the use battling for change and progress if management seems perfectly comfortable with classic gas measurement devices and techniques.

GAS Magazine no longer intends to lend tacit approval to this situation. As can be seen on page 125, we are starting a new monthly "corner" where measurement can feel right at home. However, we did not intend to limit this feature to gas measurement as it is known today. Looking toward the future, we added automation and control to the title.

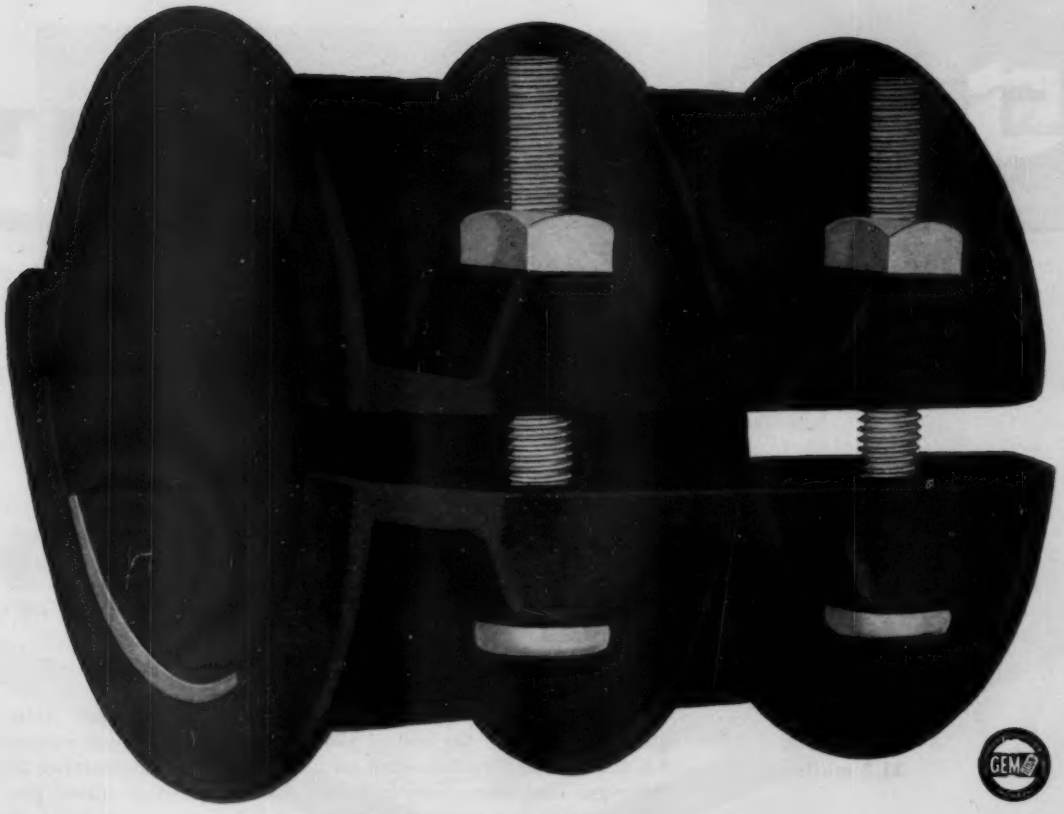
Thus, measurement men, management, instrument explorers, automation engineers, computer conquerors, and just plain vanilla gas industry readers with a yen for progress, can keep up with changes as they occur through what we call our MAC (for Measurement-Automation-Control) column each month. For the more communications minded, we have our Communications and Tele-Control column on page 127. It will remain a monthly feature, with its slight name change.

Head swamper for GAS' New Measurement-Automation-Control feature will be Ken Kridner. We latched on to Sir Ken on his return from front-line service with the Fish Engineering legions on the natural gas project in Argentina. Prior to that campaign he was a supervising measurement engineer with Colorado Interstate and was, as I recall, senior development engineer with that company at the time he took to the Pampas.

Through these Measurement-Automation-Control and Communications & Tele-Control features, we hope to help you open some of the doors to the future in the gas industry. Changes will come; doors will open; nothing in the gas industry will remain static. And we'll see that measurement technology, personnel, and departments get the attention they have long deserved.

J. Ford Eldan

EDITOR



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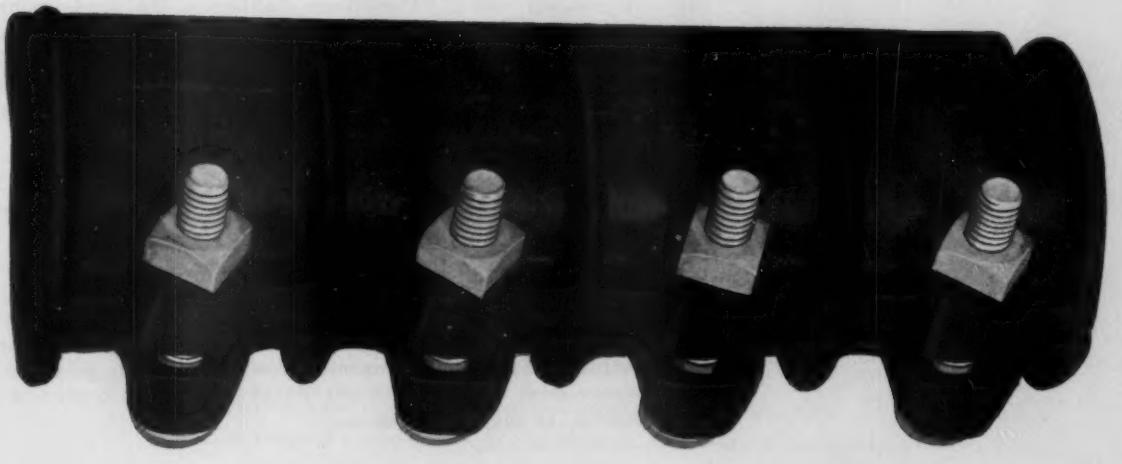


GAS HIGHLIGHTS

NI-Gas to test new storage field

Northern Illinois Gas Co. has started preliminary development of a new underground gas storage reservoir near Crescent City, Ill. The move followed Illinois Commerce Commission approval. Proposed gas supply, which must have FPC approval, will be from a tap on Midwestern Gas Transmission's system near Gilman, Ill. M. G. Markle, NI-Gas vice president, estimates the storage project will be operable for the 1962-63 winter, and will provide about 100 MMcfd for NI-Gas customers.

Kline calls for new gas bill

Congress should enact new natural gas legislation to give FPC authority to set area prices for natural gas, and supply the regulatory agency with a specific formula for evolving producers' costs. These ideas were advanced by FPC's Arthur Kline. He further favors complete separation of cost of liquids and cost of gas in determination of cost-of-service for producer price matters.

Natural gas serves 31.2 million

Natural gas gained more than a million users during 1960, AGA recently estimated. Thus, at the end of 1960, a record 31.2 million customers—out of a total of 33.3 million—had natural gas service. Remaining 2.1 million utility-gas customers were delivered manufactured or mixed gas. During 1960, natural gas customers increased 3.8 per cent to build that fuel's share of the total utility-gas market to 93.6 per cent.

AGA forms automation group

An automation committee has been formed by AGA. It will expand and coordinate industry activity in this area. Specific purposes are: (1) collect and distribute information about automation; (2) recommend economical application of automation; and (3) suggest research projects. Neal B. LauBach, vice president-operations, Colorado Interstate Gas Co., Colorado Springs, is committee chairman.

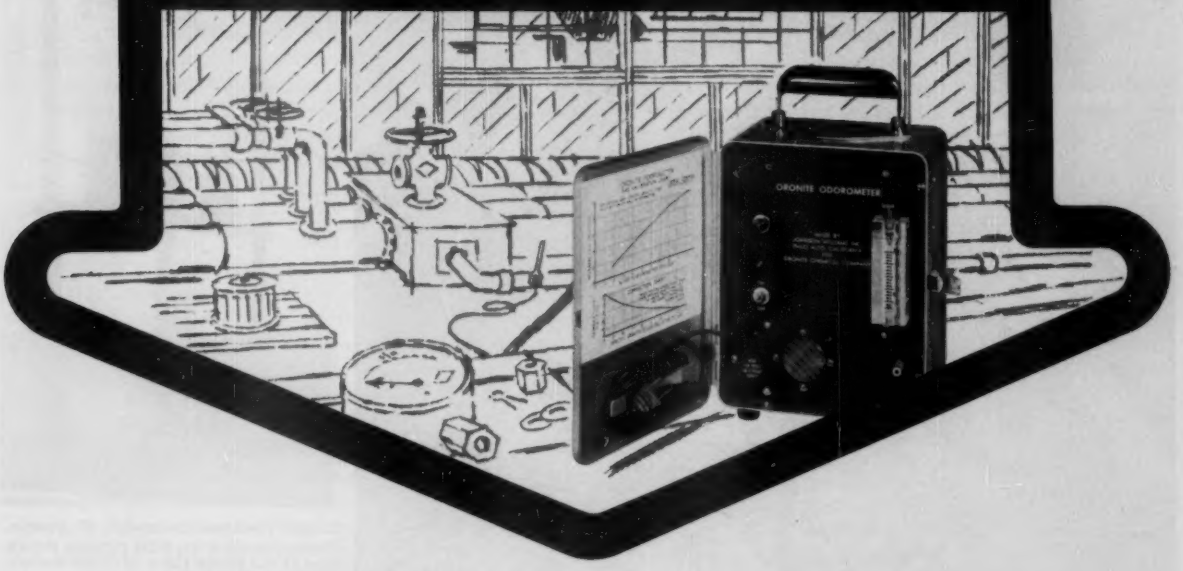
Transwestern dedicates system

Transwestern Pipeline Co., Houston, officially dedicated its in-service natural gas pipeline system April 19. Ceremonies were held in Roswell, N.M. Near that city is the control center from which one man can push-button operations throughout the highly automated, $189-million pipeline currently moving energy to southern California. On hand—many via chartered airliners from Houston and Los Angeles—were several hundred gasmen, officials from several states, and other interested people. Tours were conducted through the ultra-modern control center to see its industry-leading concepts; a unique engine-driven centrifugal compressor station; and a sophisticatedly instrumented gas quality control laboratory.

Small producers balk

Opposition is growing among small independent gas producers to President Kennedy's plan to exempt them from FPC regulation. Many feel their prices will be pegged to the majors anyway. And, the Kennedy proposal would deny them forum for redress if they feel they have been injured. Others are sure the plan is simply unconstitutional due to its discriminatory nature. And some say it will force them to sell off reserves, or take other action as their companies grow, to keep from going over the point-of-regulation. Most (if not all) would like to be decontrolled; but, many deplore the suggested method.

The Odorometer was developed by Oronite as a service to the gas industry. It is an inexpensive portable instrument for evaluating the odor intensity of a gas stream. As it is capable of mixing gas with air in known ratios from one-twentieth of 1% to over 1%, both "threshold" and "adequate" odorization levels can be judged. Simple to operate by one person, there are over 500 Odorometers in use today. For complete information and a demonstration of the Odorometer, contact the Oronite office nearest you.



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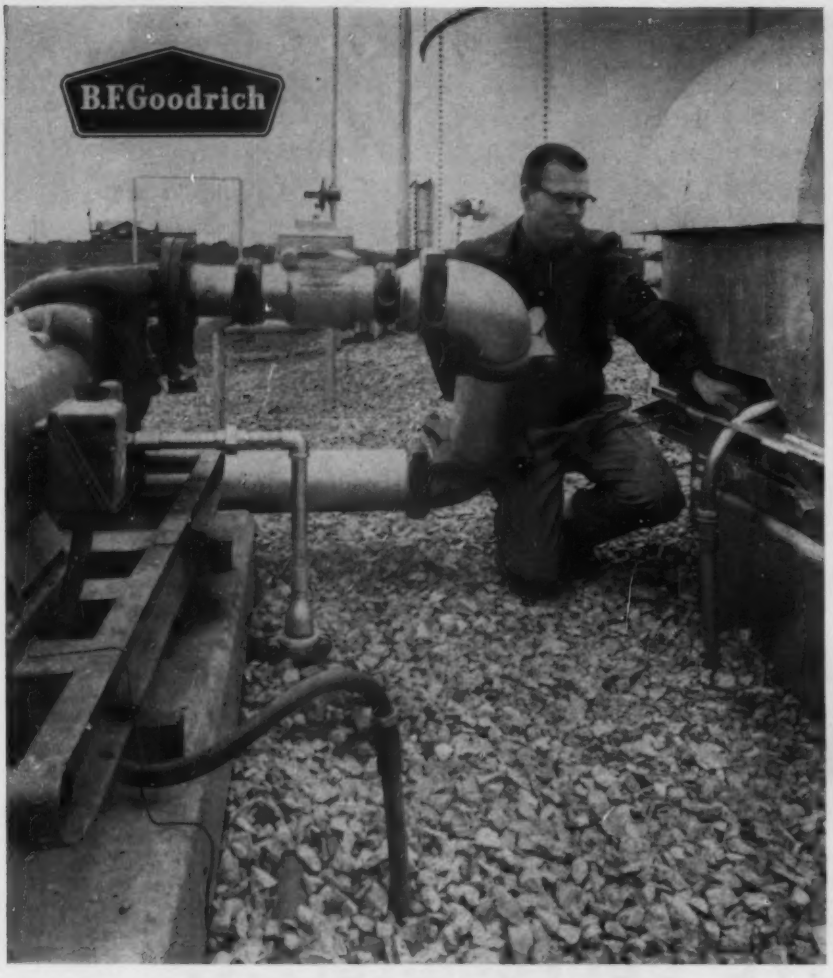

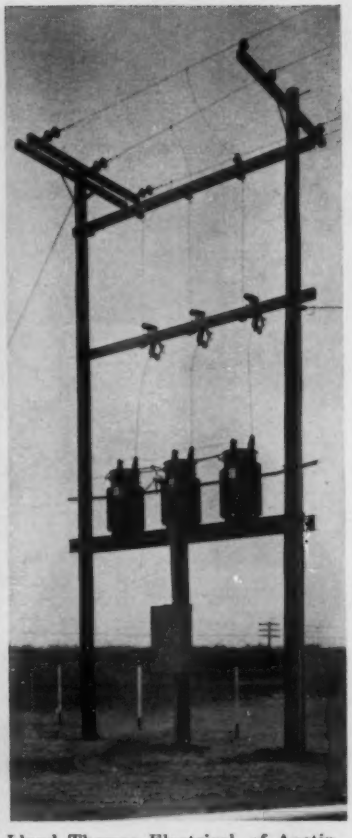

Lloyd Thomas Electrical, of Austin, Texas, installed the rigid conduit shown here at the Pierce Lease of Cities Service Petroleum Co., about five miles south of Electra, Texas. Conduit and fittings are manufactured of rigid Geon supplied by B.F.Goodrich Chemical Company.

Electrical contractor reports:

Conduit of rigid Geon solves salt water corrosion problem in flooding operations

Secondary recovery operations in Texas oil fields involve the injection of salt water under pressure into oil formations. This salt water can cause a real corrosion problem with metallic conduit, resulting in short circuits and costly shutdowns. The solution: Conduit made of rigid Geon vinyl.

"Using metal conduit, an installation rarely lasts more than six months," the contractor says. "In fact, we've had instances of short circuits in as short a time as six weeks. However, it is more than a year since we made our first installation of rigid Geon and there has been no need for repair or replacement."

Rigid Geon not only resists most causes of corrosion, it gives conduit impact resistance and tensile strength. It is lightweight, easy to install. Crews like to work with it.

Here's another way rigid Geon is helping to solve application problems — making possible new products and new markets. For more information, write Department NS-3, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. In Canada: Kitchener, Ontario.

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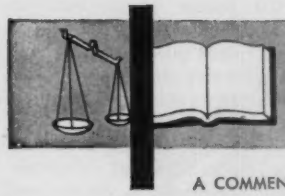


Regulatory and Legislative Trends

A COMMENTARY ON NATIONAL AND STATE DEVELOPMENTS BY AN EXPERT IN UTILITY LAW

Indefinite price escalation outlawed

IT was expected that FPC would take a bold step to outlaw indefinite price escalation in gas supply contracts. FPC did it with ample reasons, and reduced the destructive chain reaction of favored-nation, spiral-escalation and similar price increase provisions.

Bills have been introduced in Congress more than once to outlaw indefinite price escalation. They did not become law, however, for reasons other than the subject of escalator contracts. Congress and FPC have not criticized definite step-up price provisions in gas contracts; for example, 1 cent per Mcf increase every five years. Those known periodic price increases are a part of the consideration for signing long-term gas contracts. FPC also permits price redetermination every five years equal to commission-approved producer gas prices for the same area.

• FPC orders

By Order No. 232, FPC amended its regulations under the Natural Gas Act. FPC has made indefinite escalation clauses, in producer contracts signed after April 2, 1961, inoperative. By Order No. 232A, FPC modified its first policy declaration. The commission said:

"We reaffirm our earlier findings that the use of long-term contracts for the sale of natural gas by producers to pipelines or to others is desirable and appropriate in the public interest but that indefinite escalation provisions are, in general, contrary to the public interest. However, it also appears that elimination of all indefinite escalation provisions would be too restrictive to enable the industry adequately to cope with possible changing economic conditions over the span of long-term contracts. Therefore, to permit pricing flexibility and to provide an incentive for long-term contracts, we should permit future contracts to contain limited price-redetermination provisions, invocable not more than once in every five-year contract period and based upon rates subject to this commission's jurisdiction (and therefore, controlled)."

FPC listened to comments on its first order, and then decided that limited price redetermination provisions are appropriate to meet the difficulty of pricing for long and unpredictable periods. FPC encourages the negotiation of long-term gas contracts. The commission's latest order states that permissible provisions for a change in a gas supplier's price are:

"(1) provisions that change a price in order to reimburse the seller for all or any part of the changes in production, severance, or gathering taxes levied upon the seller;

"(2) provisions that change a price to a specific amount at a definite date; and

"(3) provisions that, once in five-year contract periods during which there is no provision for a change in price to a specific amount (paragraph (2)), change a price at a definite date by a price-determination based upon and not higher than a producer rate or producer rates which are subject to the jurisdiction of the commission, are not in issue in suspension or certificate proceedings, and are in the area of the price in question."

• FPC gives convincing reasons

In a companion producer rate increase case, FPC found that indefinite escalation provisions in gas sales contracts are contrary to the public interest. FPC, however, concluded that it did not have power under rules of law to declare them void in Pure Oil Co.'s contracts for natural gas sold to El Paso Natural Gas Co. The commission, therefore, in the concurrent order amended its rules to outlaw indefinite price clauses in future supply contracts. Let us examine the commission's convincing reasons for its important policy determination:

The record shows that Pure Oil's favored nation clauses are contrary to the public interest. First, they are, in the context of commission regulation of producers under the Act, in their effects inherently unreasonable. Under Pure's provisions, the company's prices are subject to triggering if El Paso pays any other gas producer within the specified geographical area a higher price. There need be no economic or other substantial justification for the increase; paying a higher price to some other producer would be sufficient to activate the increase. In the commission's view, such an artificial ground for a proposed increase, operating in an arbitrary manner, and lacking any substantial relationship to the factors which bear on the value of gas or on a determination of a reasonable rate for it, does not constitute a proper basis for a proposed increased rate or a justification for FPC's giving effect to a filing. The commission thinks that is so, at least if the rate is in excess of those in producer price Policy Statement 61-1, as amended. Although other types of indefinite escalation provisions are triggered by other kinds of mechanisms, they are in principle subject to these same objections.

The injury resulting from the practical effects of these clauses is exemplified by the evidence. El Paso showed that escalation increases under clauses like those of Pure Oil's if activated by West Texas Gathering Co.'s sales will total $18 million annually. Furthermore, El Paso stated that the filing of such increases for its gas supply will require the company to propose increases in its rates. And it points out that by spiral escalation clauses in its contracts with

Phillips Petroleum Co., Phillips is entitled to file for an increase based upon El Paso's price increase to its customers. Since Phillips will be permitted to collect this increase under refund obligation, says El Paso, once again the other producers will be entitled to file for increased rates under their escalation provisions and the cycle will start anew. According to El Paso, if the Pure Oil rate increases become effective, El Paso's gas purchase costs directly and indirectly will be increased from $35 million to $51 million annually, in excess of El Paso's rate increases sought in its rate filing.

Facts forcibly indicate the harmful effects that Pure Oil's escalation clauses, and similar clauses in other contracts, have on the public interest. Furthermore, the problems engendered by such escalation clauses arise not from just a few contracts, but from the interaction of many such provisions, so that the problem cannot be solved simply by action aimed at a few, but from remedial action taken with respect to such provisions generally.

The public is also injured in a number of less immediate but undesirable ways by these escalation provisions. Under Pure Oil's interpretation of the Natural Gas Act, escalation increases would take effect subject to refund after the expiration of the statutory suspension period. Thus, lacking substantial support and without the basis for any reasonable expectation that the higher rates will ever be substantiated, customers would be charged increased rates and new higher rate levels would exist. Although the higher gas rates were collected subject to refund, the damage resulting from their inflationary impact would be done.

In addition, it is true, as the commission's staff contends, that the tremendous number of escalation increases caused a very heavy administrative burden on the commission. The difficulties in dealing with such proposed increases result not merely from the large number of increases; they flow also from the complexity of many of the controverted contractual provisions FPC is required to interpret. A comparison of all the factors listed in the contracts involved would necessitate many dozen different comparisons. At the least, as this case demonstrates, the interpretation and application of escalation clauses involve controverted factual problems and difficult legal questions. The importance of considering administrative burdens lies in the disproportionate time and effort spent in dealing with escalation increases.

Pure Oil in taking the position that its escalation provisions are not contrary to the public interest, relies heavily on evidence adduced by its witnesses. These witnesses sought to justify these provisions as proper means of pricing producer sales. They say that "flexible forward pricing" provisions are the product of competing forces of supply and demand, and that by giving effect to free market influences in fixing prices gas resources are directed to their most efficient and socially desirable uses. Pure Oil claims that such provisions assure the long-term gas supply contracts and financial commitments which underlie pipeline development and service to the public. Without long-term supply contracts, future supplies of gas cannot be assured, Pure Oil argues, and the risks of pipelines and difficulties of financing are greatly increased. Also, producers must be able to employ favored nation clauses if they are going to enter into such long-term contracts, says Pure Oil. The company contends that in the face of rising trends in costs generally and the decline in the value of money, an unchanged gas price would result in substantial liquidation of the investment values of producers, with adverse effects on the ability of producers to attract investment and to maintain continuing supplies of gas.

In the commission's opinion, such testimony is not compelling nor are the considerations advanced by Pure Oil of controlling importance. As to giving effect to the benefits of a free market, it is fallacious to assume that the price for a few sales, which is all that is needed to activate a large number of producer prices under escalation provisions, is representative of market conditions generally. Escalation provisions like Pure Oil's are the opposite of giving effect to prevailing market prices; instead, the prices for sales of one or a few producers increase the level of market prices generally. Moreover, Pure Oil's witnesses did not consider numerous restrictions on supply from governmental proration and conservation measures, which largely vitiate their premise of free markets.

Assuming that indefinite escalation clauses in natural gas producer contracts had justification years ago, when a lack of outlets and consumer demand forced prices to abnormally low levels, this justification no longer exists. Today, purchasers of gas are numerous, consumer demand is strong, and buyers are competing for available supplies. In the commission's judgment, in the light of continuing increases in the price of gas and the present high level, escalation clauses like Pure Oil's have outlived whatever economic function they may have had.

Pure Oil points to escalation provisions in contracts for the sale of cotton seed, cotton goods, logs, parcels of land, contracts for wage rates, contracts for equipment and supplies, leases for real estate, and many others. These are claimed to exemplify the desirability of arrangements for future prices determined by reference to some economic variable. But it cannot be assumed that contracts such as these necessarily resemble those of Pure Oil in their pricing provisions. Pricing practices appropriate to commodities and businesses, which are either unregulated or are subject to a type of regulation wholly unlike gas regulation, have little applicability in pricing practices for the regulated producer segment of the natural gas industry.

Pure Oil contends that the elimination of favored nation clauses would harm the public since it would reduce the incentive to explore for gas and reduce the supplies made available to interstate markets. Pure Oil says that prices under fixed-price contracts would be higher than prices resulting from favored nation clauses.

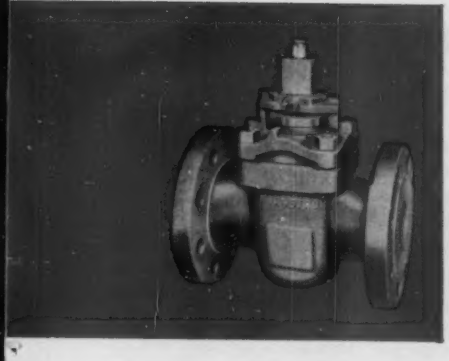
If additional incentives are necessary, measures can be taken to supply them and they would not be accompanied by the harmful effects that flow from automatic escalation clauses. As to higher prices and more frequent rate increases from fixed-price contracts, FPC thinks it unlikely that would result from curtailing increases generated by mechanical and arbitrary indefinite escalation provisions, in favor of proposals solidly based on a rational connection to the factors of significance in determining the proper price for gas.

• FPC's latest word

In its most recent Order 232A, FPC asserts:

"Gas supply contracts containing provisions for rate changes dependent or based in whole or part on indefinite escalation clauses such as favored-nation, unlimited redetermination or renegotiation, spiral escalation, inflationary adjustment, price indices and revenue-sharing clauses have contributed to instability and uncertainty concerning prices of gas and service expansion by natural gas companies. As found by us in the proceeding of *The Pure Oil Company*, Docket No. G-17930, Opinion No. 341, these indefinite escalation provisions are in general contrary to the public interest. Such escalation provisions,

(*Continued on page* 80)



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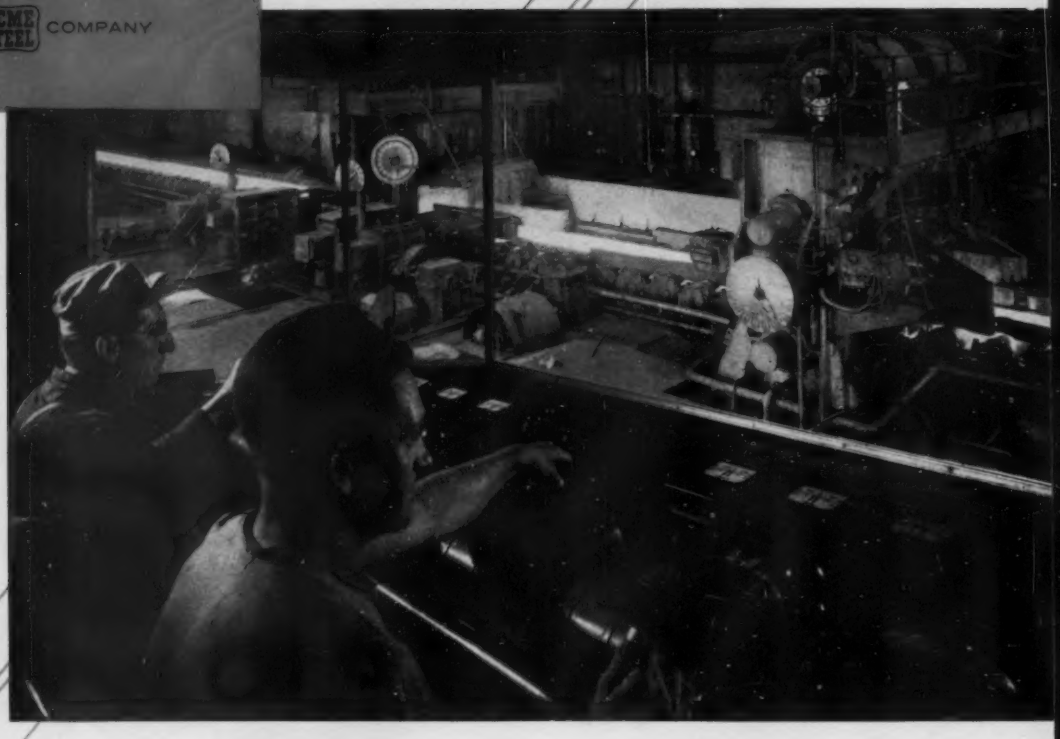

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6⅝	.156″	10.78
	.188″	12.89
	.219″	14.97
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	.280″	18.97

TECHNICAL TRENDS

By GUY CORFIELD
Professional Engineer,
Los Angeles

Refrigerated storage for propane

A new method of refrigerated storage for propane is now being developed. By maintaining propane at about −45 deg F, it can be stored at atmospheric pressure. Therefore, much thinner and lighter vessels are needed and the overall economy of storage, over pressure containers, is said to be considerable.

Minneapolis Gas Co. is building a 120,000-bbl, 106-ft diameter and 100-ft high, double-walled refrigerated tank.

The Japanese are constructing a refrigerated LPG tanker which will hold 180,000 bbl at −40 deg F. It will transport LPG from Kuwait on the Persian gulf to Japan, where it will be used for both industrial and domestic purposes.

The atmosphere pressure of the chilled liquid will permit the use of square or rectangular tanks, to give 25 per cent more space as well as reduced tonnage of steel.

Fused salts

As high temperatures become more important in industrial processes, increasing attention is being given to fused salts. Involved are practical application and research - development. The term fused salts is applied to chemical compounds commonly referred to as "salts" such as sodium chloride or potassium sulfate, which are heated to the molten (but not to decomposition) state. This requires temperatures of the order of 1000 deg. F or higher. A field of expanding utilization is offered to the gas industry.

These liquid salts are in many ways similar to salts in water solution. They are largely in the ionic state. They will dissolve many other materials. They have low viscosity and good electrical conductivity. Further, they are chemically stable, have low vapor pressure, and therefore do not evaporate.

Many metallurgical uses have been found. Aluminum, magnesium, and sodium, and some of the less common metals such as titanium, are produced by fusing their salts with other salts (such as sodium and calcium chloride) and electrolizing the mixture. Hot salt baths are used for heat treating of metals, for fluxing and descaling, and other surface protection and preparation.

Molten salts are also excellent heat transfer liquids for many processes. They can be used in nuclear reactors to function as both primary and secondary coolants. Heat transfer is normally through pipes in which the liquid is circulated. Because many of the salts are quite inert, direct contact is possible in some instances. For example, the temperature of some gases, vapors and granular solids can be controlled by bubbling or otherwise passing them through the liquid.

Of direct interest to the gas industry is the fuel cell development now under way, using an electrolyte of molten carbonate salts. This promises to enable fuel cells to successfully consume natural gas for the generation of cheap electrical power.

Explosions "nipped in the bud"

A technique has been developed and industrially applied to sense and suppress an explosion immediately after its initiation before it becomes powerful or extensive enough to be destructive. It literally prevents a little explosion from becoming a big one. The idea originated in England during World War II to protect fuel tanks from exploding after incendiary bomb hits. The system basically includes detection of the ignition, suppression, in some instances isolation, or relief of the explosion. This occurs in a period of milliseconds through specially developed sensors, and controls that operate with detonative speed and force.

The detector can be responsive to either pressure or radiation. It produces an electric signal when it feels or sees an explosion. The signal opens a rupturable container or high-rate-discharge bottles which instantly fill the space with spray and vapor, cooling and snuffing out the flame. Water or bromochloromethane are two liquids used. In some applications, added or alternate functions can be set up so that the sensor will instantaneously confine the space by closure of isolation valves, or open venting or explosion relief passages, or "inert" other portions of the plant.

Fenwal Inc., of Ashland, Mass., has been licensed to handle this system of explosion protection in the U. S. and Canada. Several test installations have been made. Suggested applications are in pulverized fuel plants, flammable fuel storage tanks, areas where combustible dusts are prevalent, chemical reactors and converters, and in flammable vapor drying chambers.

1960 research highlights

The National Bureau of Standards has prepared "1960 Research Highlights" describing "important accomplishments by the Bureau at the frontiers of physical measurement."

It is "designed as an informative report for research scientists, engineers, technologists, and scientific and industrial management . . . describes research and measurement activities in 18 scientific fields, which are represented by approximately 225 specific programs." Among these are electronic calibration, high-temperature thermocouples and ultra-high pressure measurement.

This report can be obtained from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at 65 cents a copy.

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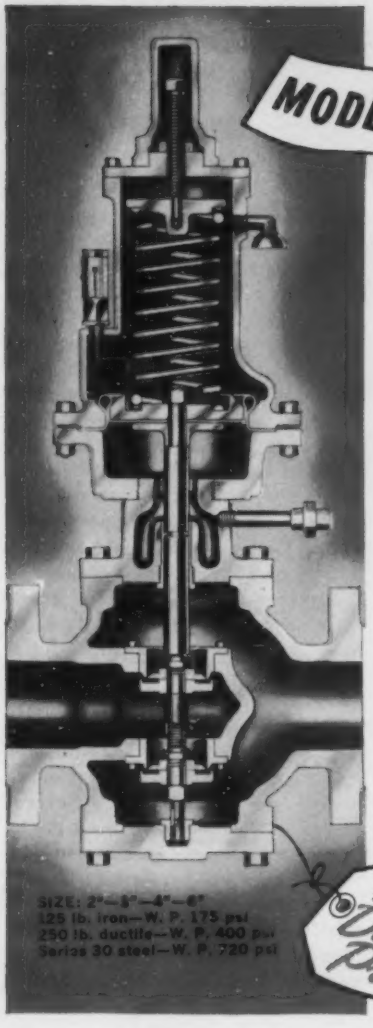

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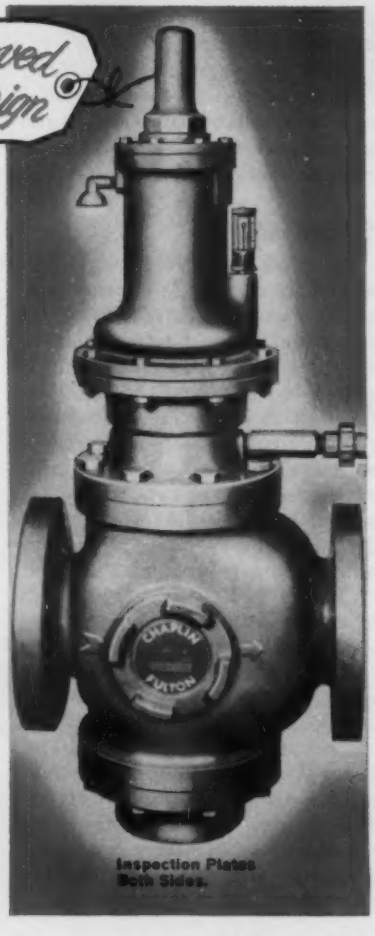

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WASHINGTON

By NEIL REGEIMBAL • GAS Washington Bureau, Washington 4, D. C.

Power struggle over FPC, gas regulation

THERE'S an intense, deadly serious power struggle quietly underway between the White House and a small handful of top congressional leaders over the fate of the Federal Power Commission and natural gas regulation.

In spite of President Kennedy's zeal for quick action, it will take months—maybe years—before anything of major importance is agreed to.

The President and Rep. Oren Harris (D.-Ark.) are the main combatants. They're thrusting and parrying. Both are masters of political fencing. The outcome is still very much in doubt.

The President touched off the fight when he appointed James M. Landis to recommend changes in the regulatory agency setup. Landis, a red-hot advocate of tight government control of industry, obviously had instructions from the White House and included several of the President's major goals in his report. These added up to a shift of control over these agencies from Congress to the White House, and the battle was on.

One of the most active flurries of fighting took place just before the President sent his regulatory agency message to Congress. Several congressmen who were given advance copies for comment urged that some key provisions be removed. They weren't, although the message was considerably less radical than the original Landis report to the White House.

Even after the message reached Congress, this infighting continued between Capitol Hill and the White House. Rep. Harris, chairman of the House Commerce Committee and the gas industry's staunchest friend on "the Hill," continued quietly insisting that the White House approach be changed. He was backed up to the hilt, reportedly, by House Speaker Sam Rayburn (D., Texas).

White House aides say privately that there has been a stream of telephone calls and visits between the gas industry's congressional supporters, the FPC, and some influential Democrats in the industry and the White House.

At times, the language used in the fight gets quite strong—but not in public. This is an intrafamily feud, not for public viewing.

Conversation in the congressional cloakrooms has it that Speaker Rayburn, Rep. Harris, and some others are most irritated because they believe the President is going too far in using the FPC and the gas industry as a political whipping boy, and that he has been badly misled by some advisors intent on punishing the gas industry for its early support of Vice President Lyndon Johnson in the preconvention days. Further, they are angry over the reluctance of the President to listen to their side of the controversy.

Specifically, these congressional sources are openly derisive of the proposal to exempt from FPC control producers selling less than 2 billion cu ft a year in interstate commerce. It is unworkable, unrealistic, discriminatory, and maybe even illegal, they say.

They are angry at the White House for what they consider back door efforts to gain firm control over these agencies by proposing to give the chairman of each one sole authority to set agency budgets, spend appropriations, hire staff, and then making him directly responsible only to the President.

As evidence of the failure of the President or his advisors to try to get the facts, or their failure to use them, these sources point to a reference in the regulatory message to the FPC backlog and by implication that 4000 pending *rate* cases if cleared would mean a big pipeline construction boom. In not separating the rate case log jam—caused simply by the ridiculous requirements of present regulatory law — from pipeline construction cases which are running through the commission at steady rates, the President has joined the ranks of those who use any gimmick to try to discredit the industry, they charge.

The prospect of delay in any action on regulatory reform now stems from the fight between the White House and congressional leaders, from the opposition of powerful congressional forces to much of the President's program, and a growing counter-offensive by the gas industry.

Rep. Harris has been meeting with a group of representatives of the three segments of the gas industry in a fresh attempt to draft a new gas bill. Once the subject of the FPC and gas regulation is opened up, the industry will press for its own version of simplifying legislation. It will probably be similar to the last Harris bill to replace utility control with commodity control.

Thus, the battle will be wide open and in public.

There is always a chance that the few noncontroversial proposals for

(*Continued on page* 20)

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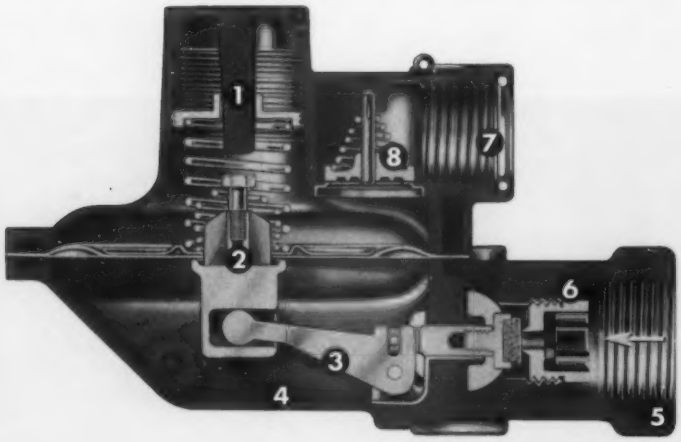

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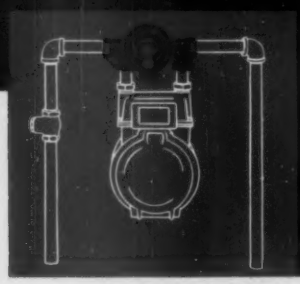

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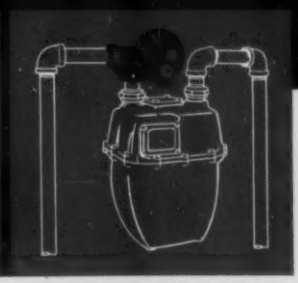

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agency reform will be sent along this year without opening the major battle. But the number of these proposals which remain noncontroversial is shrinking daily.

For instance, the President had proposed that a new code of ethics be drafted for all regulatory agencies, limiting contacts between the commissions and outsiders. Rep. Harris has proposed a similar restriction. But when the President sent his specific recommendations to Congress, they included banning not only contacts by industry spokesmen on pending cases, but by congressmen as well. Many lawmakers insist that it is proper for them to talk to these agencies about cases involving their constitutents.

Some of the Kennedy proposals are still noncontroversial. One would add two members to the FPC, creating a seven-man commission, and permit the President to name the chairman. Rep. Harris has already introduced such legislation. Similarly, requests for more power for hearing examiners and raising salaries of commissioners and examiners are generally supported.

So far, the President's request for a measure to exempt from detailed FPC control pipeline projects to simply expand and extend service to existing customers as long as service and reserves are protected is noncontroversial.

His plan to split the FPC in half —one half for gas, one for electric regulation — is scorned by Rep. Harris and others as too inflexible. They do support giving the chairman the right to create small panels of commissioners to handle specific problems and policy planning, however.

There is also some support in Congress for requiring all rate increases which go into effect subject to refund to be put into escrow. This will probably be opposed by industry, because it would remove a source of capital funds, even though as the President points out such contingent liabilities often damage a firm's credit standing.

His call for more coordination between the various regulatory agencies, and his demand for closer liaison between the White House and these agencies (he did not ask for creation of a "czar") do not require legislation, but could be spelled out when the other controversies are settled.

Bills to put the President's small-producer exemption into effect have been introduced. Both Rep. Harris, and his counterpart in the Senate, Chairman Warren Magnuson of the Senate Commerce Committee, say they'll probably hold hearings on the regulatory agency and gas industry problems this year. But neither appears to expect any action to come before this summer's congressional adjournment.

In addition, a Senate Commerce subcommittee has proposed new laws to double the term of FPC commissioners to 10 years; to prevent one interim rate increase from going into effect while an earlier one is still pending before the Commission; create a special White House reorganization office; and speed court review of the agency's decisions.

Meanwhile, Congress has passed one measure which will become a factor in the regulatory agency problem. This is a law restoring to the White House the right to make sweeping changes in government agency operations, subject only to congressional veto. Under this power, either the Senate or the House would have to specifically veto a Presidential reorganization plan within 60 days, or it would become law. This power was first granted in 1949, but allowed to expire two years ago.

There are limits on the reorganization powers under this act, but a firm chief executive could use it for a wide variety of changes. ■

Promoting competitors

WHILE the heat is being turned on the gas industry through reorganization of the Federal Power Commission, the Kennedy Administration is promoting in several ways the interests of the industry's competitors.

The Administration is firmly behind the coal-industry's drive for a national fuels study. President Kennedy said in a telegram to a National Coal Policy Convention dinner that: "The coal industry obviously needs assistance. . . . I am determined that we shall help."

Interior Secretary Udall at the same dinner followed up by saying, with the blessing of the President:

"The Administration wants a type of long-range fuel study, a balanced study, that will look into the subject very thoroughly and will use the only yardstick and the only test that I think your industry wants, and that is what is good in the long run for the country."

"We can not in something as important as fuels and energy let policy be set by drift or by default," he added.

Indications were in early March that the Senate may wind up making the only congressional study. Senate fuels policy supporters were hoping to win House Speaker Sam Rayburn over to creation of a joint Senate-House study committee, instead of the simple House committee study which was pending. But House leaders indicated instead that they would hold up the House proposal, and if the Senate set up its own study, would drop the one in the lower chamber.

Meanwhile, the White House is also asking for a hefty increase in the Rural Electrification Administration's loan fund. He wants the fund increased by $50 million over the $172 million former President Eisenhower had proposed.

President Kennedy is also asking for an extra $2.3 million to build additional electric power transmission lines for the Bonneville Power Administration.

The Interior Department's coal research program, authorized by Congress last year, is also getting up a full head of steam. The President has named George A. Lamb, former government fuels official and one-time business surveys manager for Consolidation Coal Co., to head the office. The program is designed to find new uses for coal, expand present uses, and cut costs of production and distribution.

By July, the Department plans to have some $250,000 worth of research projects underway. By the end of the next fiscal year, the program will be costing taxpayers $2 million a year.

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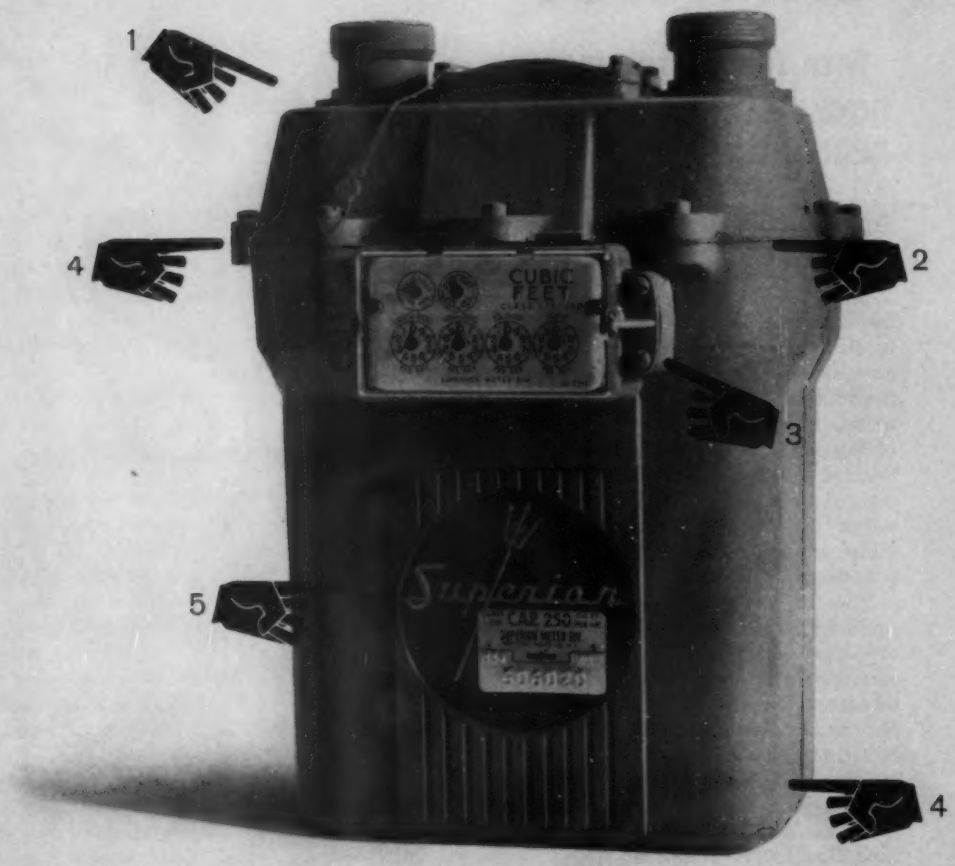

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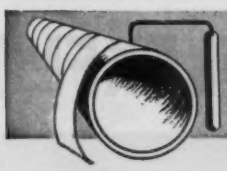

Is cathodic protection harmful?

By MARSHALL E. PARKER
Consulting Engineer, Houston

CAN cathodic protection inflict damage on the structure it is supposed to be protecting? It is well known that other structures, not connected to the cathodic protection circuit, can be damaged by stray current, or, as the phenomenon is usually known in this instance, by interference. The mechanism by which this takes place, and the remedial measures with which it can be controlled, are not of concern at present; the question of interest here is that of damage to the structure which is supposed to be under protection.

And the answer to this important question must be that, under certain circumstances, this kind of damage can occur. There are some instances in which so-called cathodic damage turns out to be something else; and some other tales of damage are entirely without foundation. But some of the damage is real.

One way in which cathodic protection can damage the protected structure is by lessening or destroying the bond of the protective coating. This occurs most easily at existing holidays; the bond is progressively damaged around the edge of the holiday, and the area of unprotected metal is thus increased. The effect is easy to obtain under laboratory conditions, particularly in liquid media of low resistivity; it is well known, in actual applications, in sea water; its extent or even its occurrence is not so well established in soil. It is especially doubtful if significant coating damage takes place at usual cathodic protection potentials and current densities in high resistivity media—and the term "high" as used here may include soils no higher than, say, 500 ohm-cm. One point of view is that adequate cathodic protection of a steel surface cannot be had without the necessity of some coating damage. If this is true, of course, then the only possible procedure is to continue the application of protection, with as little excess as possible, in gradually increasing amounts, and simply tolerate the coating damage. This view is felt to be extreme.

Amphoteric metals, such as lead and aluminum, are under some conditions subject to cathodic corrosion; that is, they go into solution when made the cathode of an impressed current cell. Again, this is an effect which is much easier to find in the laboratory than it is in actual practice; some authorities hold that it does not exist in practice. What can and does occur is that cathodic protection causes a build-up of a strongly alkaline environment in the vicinity of the cathode; if the protection is ever interrupted or discontinued, this alkaline environment will then attack either lead or aluminum quite rapidly. For this attack, a more precise term might be corrosion by cathodic products.

Another phenomenon of which much is heard but little verified is that which is supposed to follow the application of cathodic protection to an old and already badly corroded line, particularly a bare line. The protective current loosens the corrosion products, which in many cases have been plugging holes already all the way through the pipe wall; the results of this loosening is an increase in the leak rate in the period immediately following the application of protection; ultimately, the appearance of leaks declines, and, if the protection is indeed adequate, stops altogether. It is probable that actual increases in leak rates do not occur; some leaks do continue to appear, of course, in a line which is already in the leak stage when protection is applied, but it is doubtful if there is any actual unplugging of plugged holes.

Often cathodic protection is quickly condemned — especially by reactionaries who were opposed to its installation in the first place— when it fails to solve all of the problems, and stop all of the leaks, instantly. This failure to bring instant relief may be due to the above-described phenomenon, or it may simply be because the system does not operate at an adequately high current level at first; often some time elapses before the system is properly adjusted, and during this time, corrosion continues, although at a reduced rate.

A variation of this situation has given headaches to a number of corrosion engineers — particularly young beginning engineers, with their first cathodic protection project. This will usually be the protection of an old line which has already developed a number of leaks and a bad reputation. The engineer will make a careful survey, and design a cathodic protection system. In due time this will be installed and adjusted, and, after a short period, the leaks will diminish and finally cease. His attention will then be concentrated elsewhere, with only enough supervision of this first job to be sure that it is still functioning. Then, two or three years later—while he is off at a convention, no doubt—word will come that the cathodic protection system is doing no good

(*Continued on page* 80)

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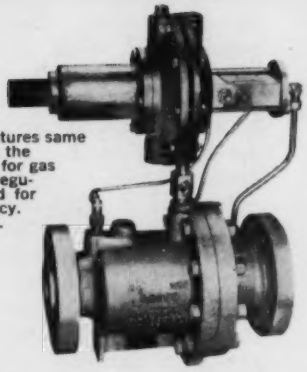
Model 80-820 where extreme accuracy is critical. Sensitive, spring loaded model 820 Grove pilot is a diaphragm controlled, three-way throttling valve. Seven adjustable spring ranges from 2 psi to 1200 psi. Send for Bulletin #813-B.



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THE GASSING GAME

By **JIM CLARK** • Gas & Oil Consultant, Houston

ONE burden of natural gas producers in Texas that is present in few, if any, other states is the unnecessary well.

Recently the Texas Supreme Court made a landmark decision in what will probably become famous as the Normanna case which will relieve this burden. But now a Houston attorney-turned-oil-promoter, who has made a fortune in drilling unnecessary wells, is exerting a strong effort toward legislation that will overcome the court's logical and popular decision.

An unnecessary well is any well drilled where another well is capable of draining the gas. These wells are always drilled as exceptions to the state spacing law, known as rule 37 of the Texas Railroad Commission regulations under the state's oil and gas conservation statutes.

For many years now the commission has taken as a rule of thumb that any gas well will receive an allowable allocation based on one third for the well and two thirds for acreage. This means that in the case of a 160-acre spacing pattern, for instance, set by the commission, a well on that pattern will get the full allowable under normal conditions. A well drilled on a smaller tract in a 160-acre pattern field gets one third of the full allowable for the well and a fraction of the other two-thirds of the allowable depending on the size of the irregular tract. An illustration is that a well drilled on a one-acre tract in such a field would get one one-hundred-and-sixtieth of two thirds on acreage and one third for the well.

There are many things wrong with this rule. In the first place the arbitrary one-third allowable on such a small tract in a widely spaced field permits the small tract owners and operators to get far in excess of their fair share of the minerals beneath the tract as compared with the landowner and operator who abides by the spacing pattern. Naturally, this excess must be drained from under other tracts. That amounts to confiscation of another man's property.

From the standpoint of conservation the ruling is even worse since it enables uneven withdrawals from certain areas of the reservoir and unbalances a program of proper reservoir control. This leads to the loss of liquids as well as, eventually, natural gas in many good reservoirs.

These small tract promoters never discover a gas reserve. It is their game to sit around and wait for a discovery and then go out and find a small tract owner and give him a big bonus and await developments that will remove any possible gamble from their drilling a well. In instances where townsites are involved this gets downright ridiculous.

The commission has based its past rulings on an old court decision wherein a judge said that any man was entitled to at least one well on his property (which no one denies) and that the commission should be certain that the owner of such a well received an allowable allocation that would assure the operator of a profit. Obviously the decision was aimed at protecting the property rights of the little man with no consideration of conservation. Now, the state supreme court has ruled that if property rights are to be considered, then the rights of the large tract operator (or the small tract drillers who have gone into units) takes precedence.

This is about as simply and as superficially as this issue can be presented here. But it might be interesting to watch for the results of the proposed legislation in the present term of the Texas legislature.

All of the major oil companies, most of the independents, and all of the state's independent producer organizations, that were in existence before the supreme court's decision, oppose any legislation that would offset the decision. One new association, formed by the Houston attorney, is vigorously promoting the legislation.

If the legislation fails, as most observers believe it will (others say that should it pass it will probably be declared unconstitutional) the burden of the gas producer in Texas will be lighter in the future. It costs a tremendous amount of money to drill a well and every well that is drilled must be paid for, especially those that produce gas. Therefore, if sensible and proper spacing can prevail, a great deal less unnecessary money will be expended in the future on wells that are not needed.

Since the issue has come up most Texas producers have started campaigning for many other changes to modernize Texas conservations laws. It is at least slightly ironic that Texas, the state which is probably responsible for influencing more good conservation laws, rules, and regulations in new producing states than any other state, should find itself now with antiquated laws on the books, and even more antiquated rules and regulations.

But that seems to be the case. ■

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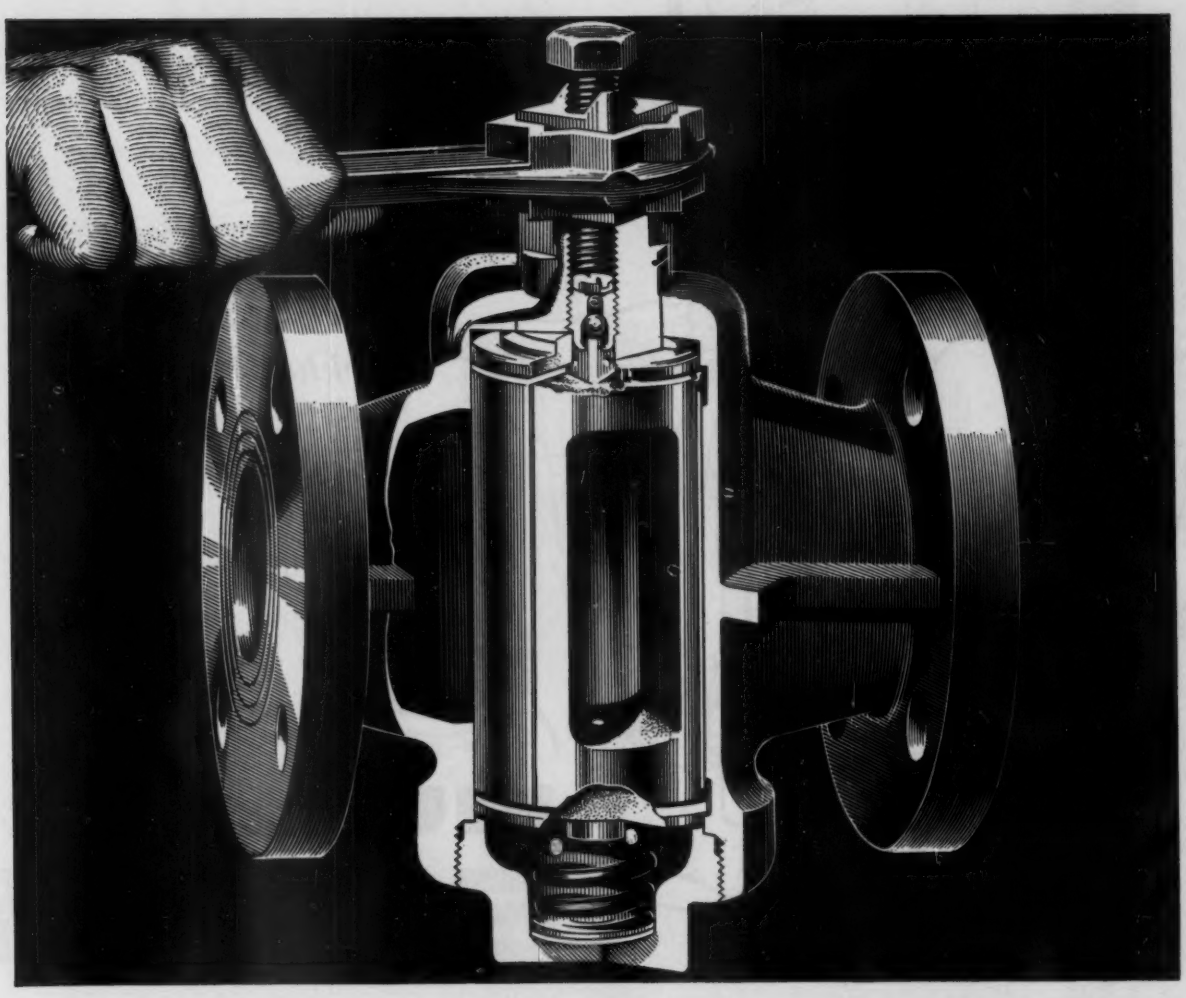

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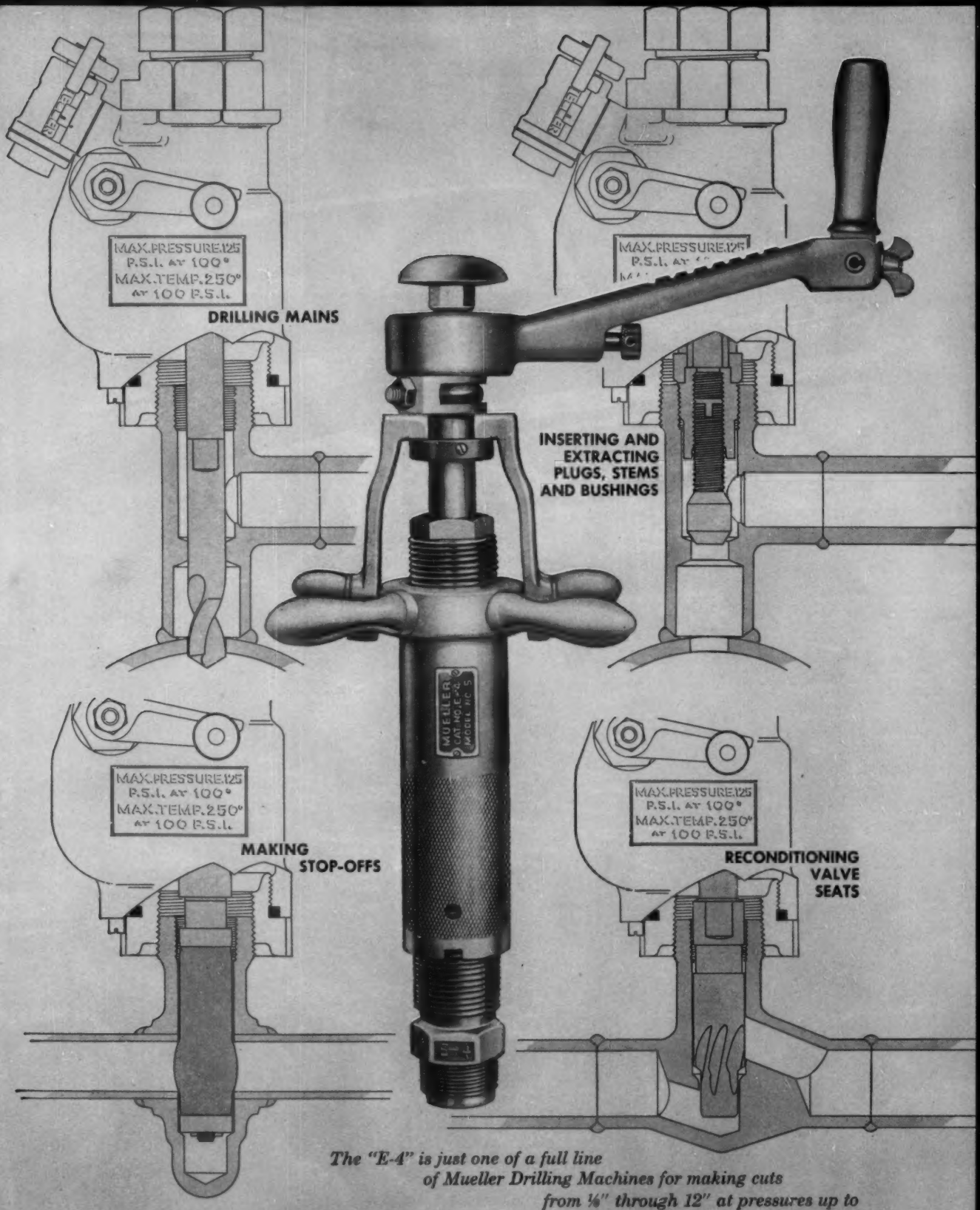
E-4 DRILLING MACHINE

More gas services have been connected with the "Mueller E-4" than with all other drilling machines combined!

Simple and easy-to-use, this hand-operated machine is still the most popular drilling machine available for making holes from ¼" to 1" in any size or kind of main. Its direct design makes it an ideal tool for ditch work. The long feed tube not only protects the easy-turning Acme feed threads from damage, it automatically cleans them during use.

The combined feed tube and yoke of the "E-4" gives positive feed for the entire length of travel and easy disengagement of feed at any time. This feature—plus the sensitive control provided by the knurled surface of the feed tube—makes the "E-4" an extremely versatile tool for gas distribution operations. Besides drilling, it can also be used to: insert or extract plugs, stems or stem and bushings of fittings and valves; stop-off fittings and lines; and recondition body seats of fittings and valves. All of these No-Blo operations are performed under full working pressure.

If you are not now using the "E-4", write for complete information and specifications—it's preferred by gas men everywhere. If you are using the "E-4", have you considered the new, improved Model No. 5? Furnished in fitted, steel carrying case.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DRILLING MAINS
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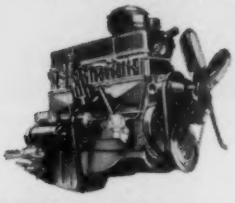
■ Because Chevy's wide choice of models (there are 15 of 'em!) means you'll get the *right* pickup . . . because each is engineered to the highest standards . . . because Chevy's rugged, smooth-riding build lasts longer, costs you less to own and keeps your profits at peak levels. Chances are, whatever you consider most important, you'll find Chevrolet has thought of it first, and done most about it. Whether you get a handsome Fleetside or handy Stepside model (or possibly a Corvair 95 Rampside or Loadside or one of a half-dozen four-wheel-drives) you'll soon be convinced that buying a Chevy pickup was the best idea you ever had!



ECONOMY

The Chevrolet slant on economy makes the most sense of all, with the tight-fisted 235-cubic-inch Thriftmaster 6 (standard) leading the way. It's the most experienced money-saver going, one that's powered more payloads than any other engine in the business. It's famous for its stingy way with a gallon of gas and also for its rock-ribbed durability. It keeps your Chevy at work, making money, instead of in the repair shop, costing. And if you prefer the extra snap of V8 power, there's the eager, efficient Trademaster V8, 160-horsepower strong and available at nominal extra cost in all conventional pickup models.

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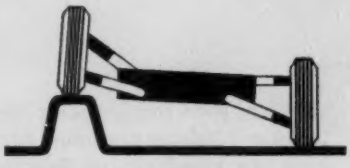
Chevy pickup bodies—6½, 8 or 9 feet long—are tops in cargo capacity and convenience, with a long list of bonus-built features to keep them working better and looking their best from delivery to trade-in. Both Fleetside and Stepside models feature select wood floors for better footing and quieter going, with steel skid strips to ease loading and unloading. Extra strong grain-tight tailgates with anti-rattle latches and support chains minimize bulk cargo leakage and offer firm support for extra-long loads. Fleetside body sidewalls are double-walled in the lower section, for extra rigidity and protection of exterior surfaces against dents caused by shifting cargo.



PROFIT-★★★★★ PROTECTING RIDE

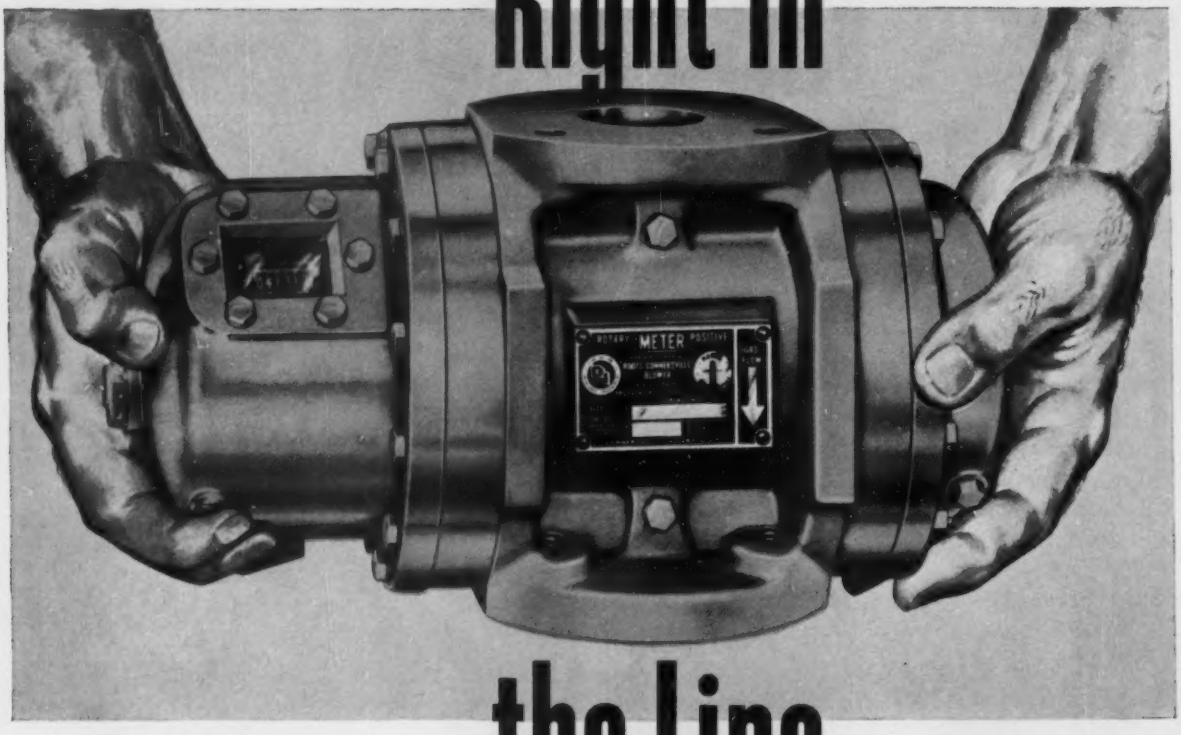
All of Chevrolet's 2-wheel-drive pickups feature years-ahead Independent Front Suspension design, with ride, roadability and ruggedness that are paying off for truckers everywhere. The reduction in driving effort and fatigue that makes a bigger day's work come easy is just one part of the three-way Chevy payoff. The same shock-cushioning action protects your cargo against damage en route, and also protects the truck itself against the bumps that can batter the life out of cab, body and chassis components. Sounds too good? . . . sample it for yourself at your Chevy dealer's, soon! . . . Chevrolet Division of General Motors, Detroit 2, Mich.

1961 CHEVROLET STURDI-BILT TRUCKS

CHEVROLET

Mount positive metering accuracy

Right in



the Line

Whether your requirements demand 3000 or 7000 cfh maximum capacity, here are Line-Mounted Rootsmeters for the easiest installation, and greatest accuracy and dependability of any gas meter. Line-Mounted Rootsmeters' advantages have been field-proved in hundreds of installations.

Either model will replace a meter 10 times its size: The 3000 cfh 3M125 is only 14 inches long, the 7000 cfh model is less than 18 inches long. And they weigh only one-fifth as much as other meters with the same capacities.

The new meters are easy to handle and easy to install for appreciable savings in man-hours and installation costs. Connections are flanged to ASA C.I. standards—just mount them directly in the line, without foundations or special supports, and they are ready to operate.

You can depend on these Line-Mounted Gas Meters because they use the Roots Rotary Positive Displacement Principle, long known for accuracy over the widest operating range. They are not affected by pressure or flow fluctuations. Their accuracy is permanent, too, they never need adjustment.

A convenient direct-reading counter is mounted in the case, or other instrumentation is easily applied.

Savings from long, trouble-free service with minimum maintenance is added to all these features for the maximum meter performance in the smallest meter package. Call your R-C Sales Engineer or write Roots-Connersville for complete details of all the advantages in Line-mounted Rootsmeters.

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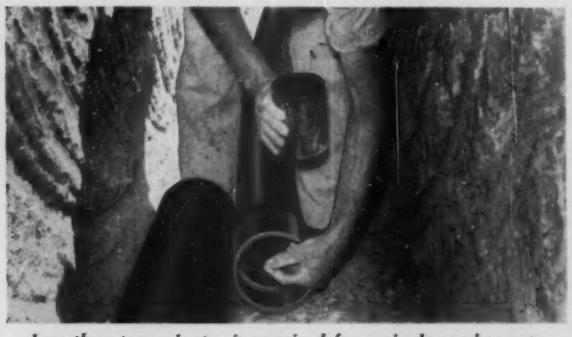
Two-man crew quickly lifts and places in position a section of six-inch plastic pipe from Plastex Plastics Co.



Less than two minutes is required for a single workman to prepare and make a permanent leakproof joint using only solvent cement.

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HIGH PLAINS SYSTEM DEFIES ALKALIZED SOILS, GIVES NEW PROOF OF SUPERIORITY OVER CONVENTIONAL PIPE

When shallow wells ran dry, forty-five ranchers in the Brighton, Colorado area pooled their resources to sink a 1,200-foot fresh water well. Established as the High Plains Water Users Association, Inc., the group was formed to bring the much needed water direct to individual homes. The only pipe that could withstand the corrosive effects of the "hot" Colorado soil proved to be ABS rigid pipe made of CYCOLAC brand polymers. Likewise, the line was installed faster, easier and at less cost than either metal or concrete pipe. In all, 83,900 feet of rigid pipe was used in diameters of one to six inches. So successful was this particular system that thirty-six similar projects are now underway in Colorado alone. Proof again of the superiority of rigid pipe made of ABS plastic.

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INSIST ON RIGID ABS PIPE
made of
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THE BORG-WARNER PLASTIC THAT IS TOUGH, HARD AND CORROSION-RESISTANT

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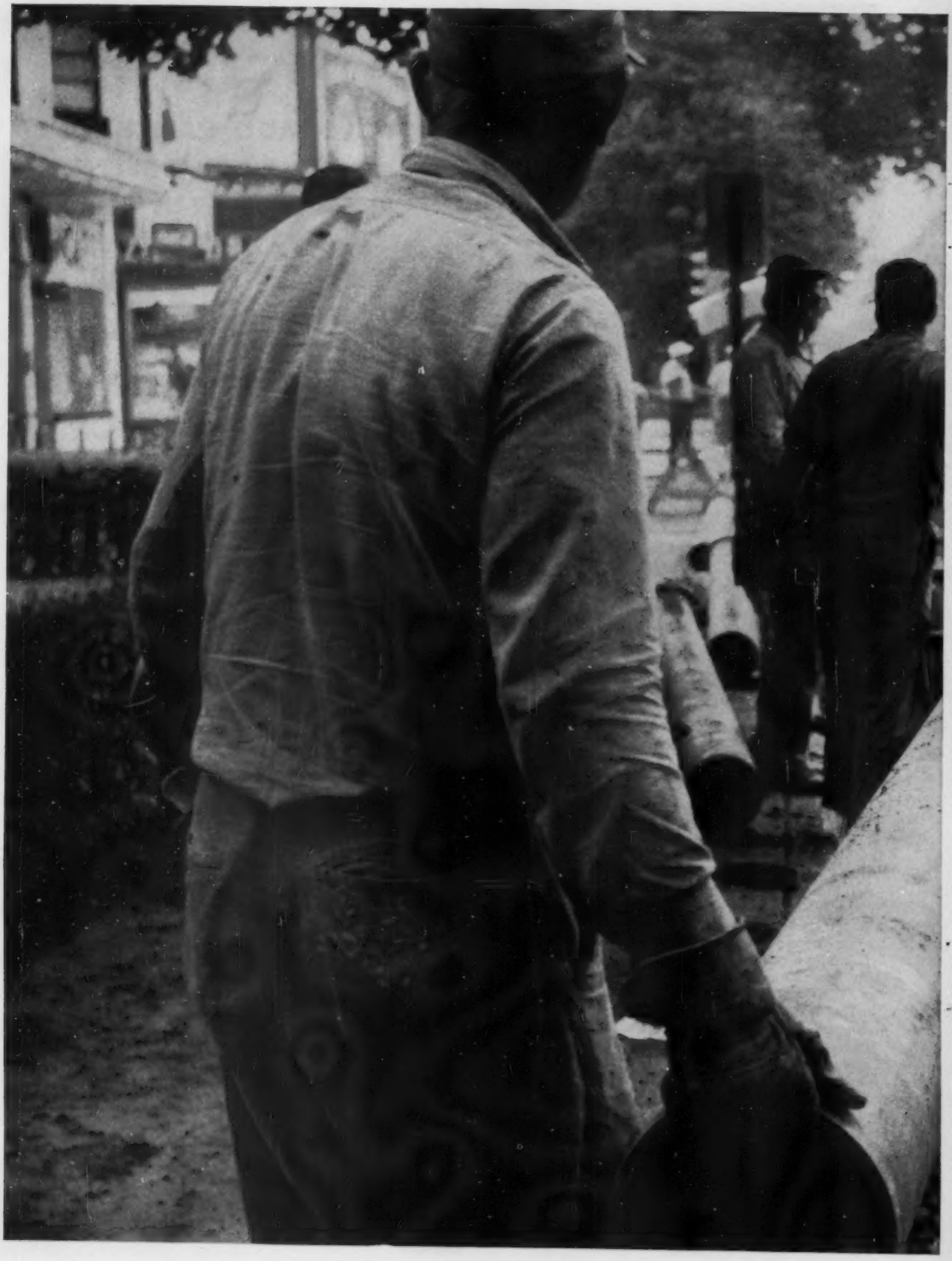

Cast iron pipe assures continuity of service

Cast iron pipe provides trouble-free service for years. Inherent ruggedness is the reason: cast iron pipe withstands all the stresses to which underground pipe is normally subjected.

Another feature of strength of cast iron pipe: bottle-tight mechanical joints. These joints put a lock on gas leaks, remain tight during all normal distribution pressures.

The ruggedness lasts for years—in fact, more than a century. Today 63 American gas utilities still use cast iron gas mains that were installed over 100 years ago.

CAST IRON PIPE
THE MARK OF PIPE THAT LASTS OVER 100 YEARS

CAST IRON PIPE RESEARCH ASSOCIATION
Thos. F. Wolfe, Managing Director
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Now "positive emergency control" to repair damaged ABS gas pipe lines

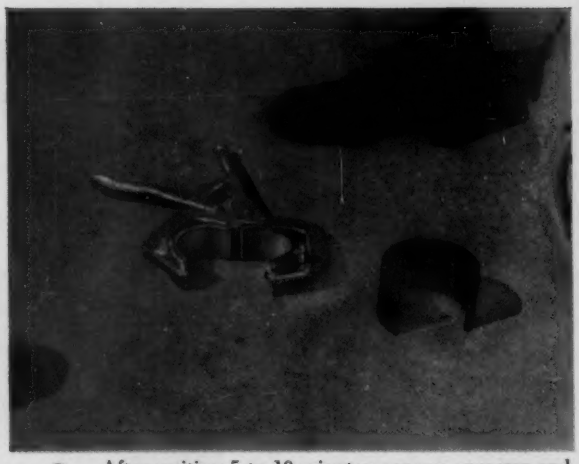
1. Using long-handled pipe squeezer, make temporary shut-off by squeezing pipe so that it touches wall to wall. Attach end cap for temporary control.

2. Place two layers of 2" glass-reinforced tape around pipe section selected for positive shut-off. Tape insures the prevention of damage to the pipe.

3. After placing squeezer on taped part of the pipe and squeezing to positive shut-off, cut off damaged end of the pipe and prepare for solvent welding.

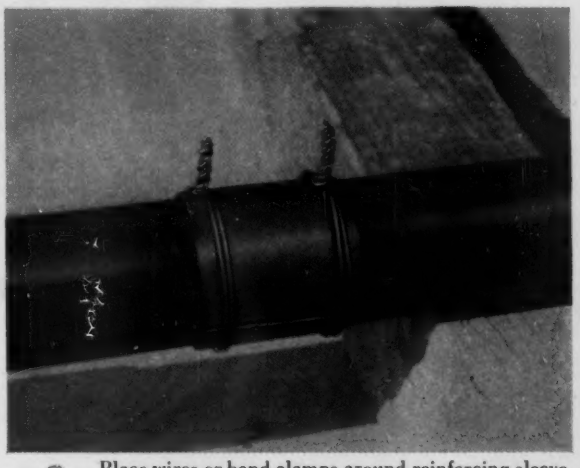
4. Apply ABS solvent cement to both ends of cut pipe and to the inside surface of the coupling. Make sure solvent cement coating is evenly distributed.

5. Join new pipe section to original pipe by forcing the coupling and pipe together. Use the same procedure to join both ends of the pipe section.



6. After waiting 5 to 10 minutes, remove squeezer and tape. Then split a 2" section of plastic pipe to use as a reinforcing sleeve over squeezed area.

7. Place the reinforcing sleeve in a vice-grip clamp holder. Apply solvent cement inside sleeve and on pipe. Clamp sleeve in the vice-grip tightly to pipe.



8. Place wires or band clamps around reinforcing sleeve while vice-grip is in place. Remove clamp and you've finished the entire job in only 20 minutes.

KRALASTIC W While some plastic piping materials are too brittle and lack the resiliency of Naugatuck's Kralastic® W, pipe made of this new ABS compound can be positively squeezed off for emergency control in gas piping systems without material damage to the pipe.

As the pictorial story shows, in just 20 minutes Kralastic W pipe can be squeezed off with emergency control equipment, pipe ends prepared, and a new section added... enabling gas companies to repair damaged lines with no more than one customer shutdown.

To find out more about this new emergency control procedure, ask your nearest pipe manufacturer to show you our detailed educational film on this subject or write for our "Gas Installation Book" at Dept. 614K, Elm Street, Naugatuck, Connecticut.

**The emergency control equipment was developed and patented by Arizona Public Service Company, Phoenix, Ariz.*

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NEW FORD ECONOLINE VANS

Now, *you can save $312 to $433 in price* alone* on a Ford Econoline Van compared to old-style half-ton panels. In addition, you can save over $100 every 16,000 miles you drive!

These savings come with a man-size truck. The Econoline's cab-forward design with welded "body-frame" gives bridge-like strength and reduces dead weight to haul a full ¾-ton. Only 14 feet overall, Ford Econolines are nimble in traffic, easy to park, need less garage space. Big 4-ft. door opening (both curbside and rear) and level cargo floor provide new loading ease . . . new load workability.

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SAVINGS ON OPERATING EXPENSES EVERY YEAR!

GAS Econoline trucks can give 30% better gas mileage than conventional ½-tonners. Figuring 16,000 miles per year at prevailing gas prices, you save..... **$70**

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LICENSE—In many states (not all) the license for an Econoline costs appreciably less—up to $30.40 per year. Average for all states is..... **$3**

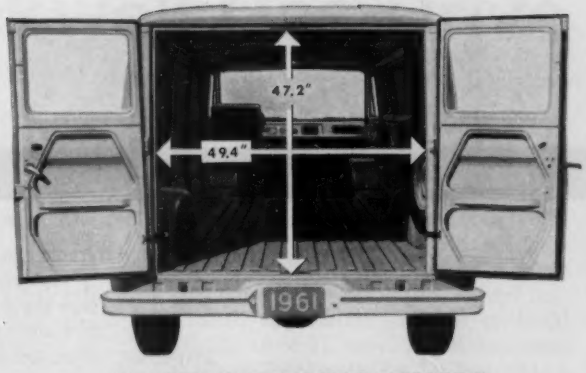
$102

SAVING ON PRICE—You can save $312 compared to even the lowest-priced conventional ½-ton panel—and up to $433 against others! Saving at least..... **$312**

TOTAL FIRST YEAR SAVINGS... $414

and you keep saving

$102 EVERY YEAR!



NO REAR ENGINE HUMP!

The Econoline's "up front" engine leaves a level, knee-high floor almost 9 ft. long. There's no awkward rear-engine-housing hump to shrink the back entrance or hinder loading. And the Econoline Van provides over 204 cu. ft. of loadspace . . . up to 57 cu. ft. more than conventional ½-ton panels.

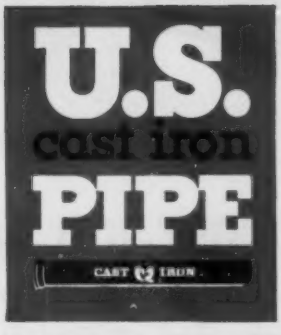
FORD TRUCKS COST LESS

SEE YOUR FORD DEALER'S "CERTIFIED ECONOMY BOOK" FOR PROOF!

FORD DIVISION, Ford Motor Company,

this means precision

so does this

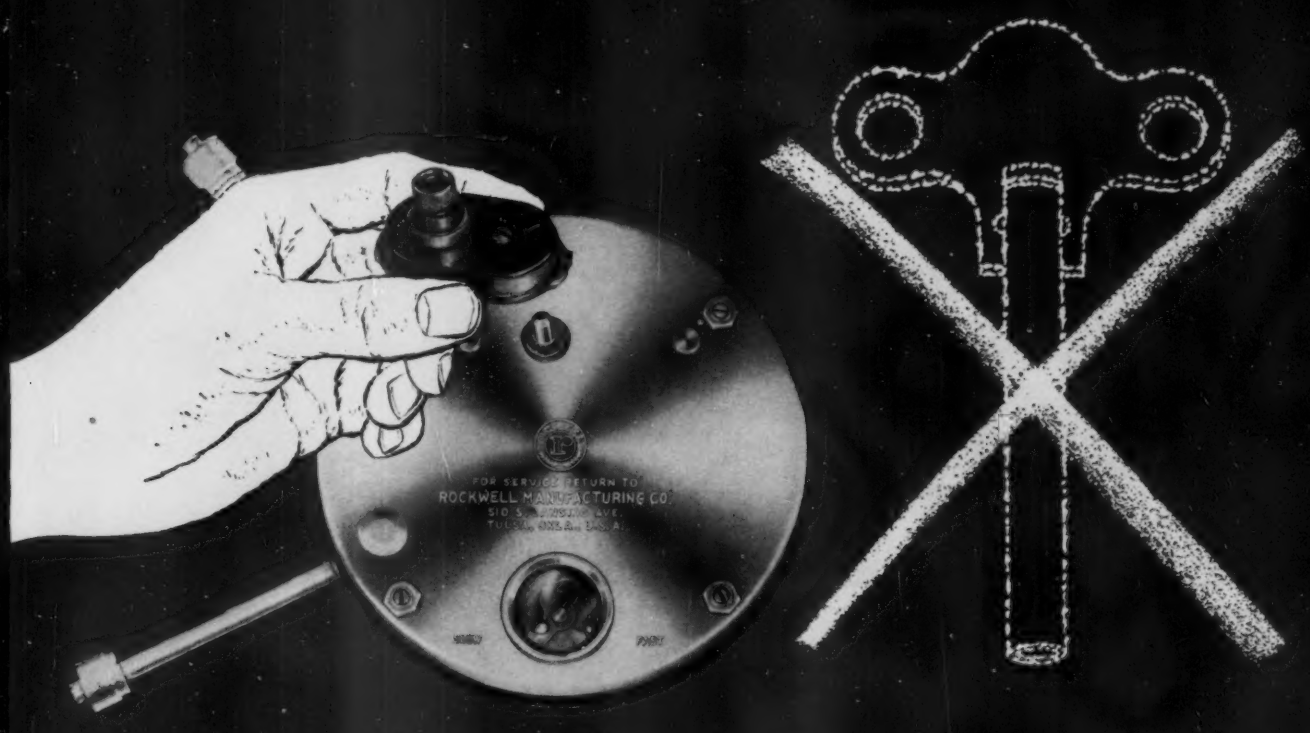


Small differences in the precision, care and skill with which pipe is made can make a big difference in the gas main. U. S. Pipe makes sure these small differences never occur. All U. S. Pipe . . . from mining of ore to finished product . . . is carefully inspected, controlled and supervised in manufacture. Every length measures up to the rigid quality standards set for it. There is a difference in pipe. The symbol—U. S. Pipe—means added precision and control that pays off in performance . . . for you.

• Standardized mechanical joints are bottle-tight for usual gas distribution pressures . . . and for all types of gas • Centrifugally cast pipe is tough, uniform, strong • Joint design allows for deflection during and after installation • Service connections are easily made • Long life is a matter of record

U. S. PIPE & FOUNDRY COMPANY
General Office, Birmingham 2, Alabama

A WHOLLY INTEGRATED PRODUCER FROM MINES AND BLAST FURNACES TO FINISHED PIPE



Illustrating how speed changing turrets are applied to the chart arbor

You never need to wind the Rockwell Gas Drive

GAS (OR AIR) POWERS THIS NEW CHART TIMING DRIVE. With it you can forget the costly chore of periodic winding. It's completely self-starting, self-contained. You can use the Rockwell Gas Drive with profit and gain accurate, automatic operation of recording charts on practically any make orifice meter, gas lift intermitter, pressure recorder or temperature gauge. It is particularly applicable for remotely located instruments.

Since the Rockwell Gas Drive consumes only 6 cubic feet of gas in 24 hours it is economical to use—safe, too, for there is no exhaust problem.

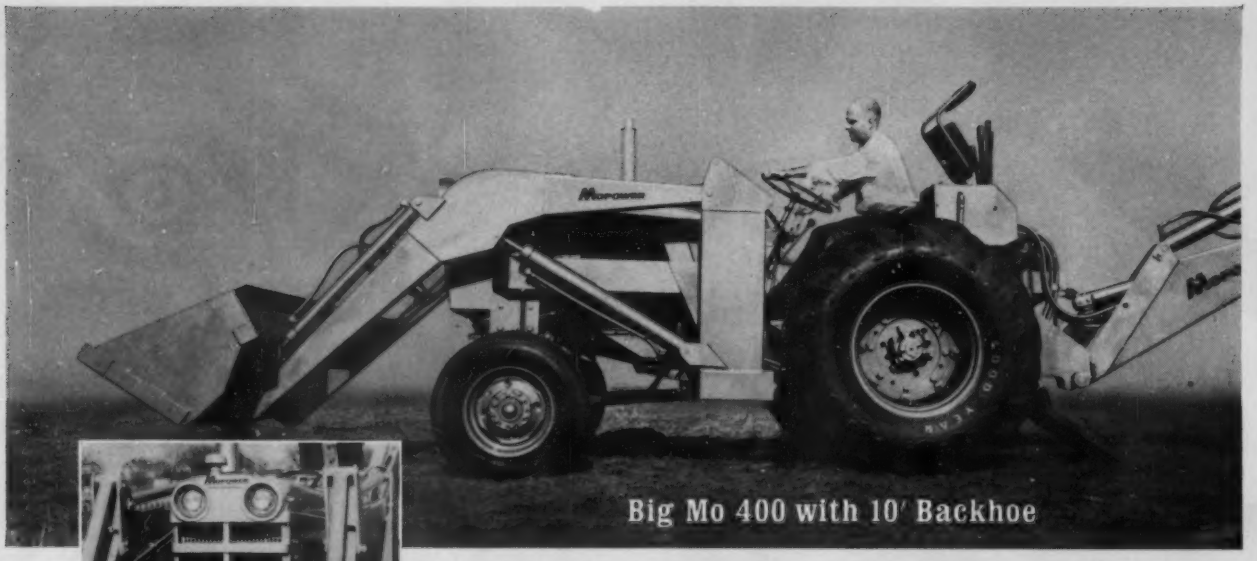
The Gas Drive operates on a pressure range of 15-25 psi and delivers 15 in. lbs. of torque to the main arbor which rotates once every 24 hours. Geared turrets which snap onto this arbor provide optional speeds of 2, 3, 4, 6, 12, 48 or 72 hour, 7 or 8 day rotation. So with a stock of Rockwell Gas Drives, plus a selection of economical turrets, you can serve all your instrument needs. Get facts now. Write Rockwell Manufacturing Company, Pittsburgh 8, Pa. In Canada: Rockwell Manufacturing Company of Canada, Ltd., Guelph, Ontario.

◀ Rockwell Gas Drive powers this typical intermitter

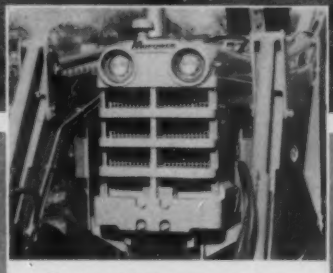
GAS DRIVES, CHART DRIVES

another fine product by

ROCKWELL

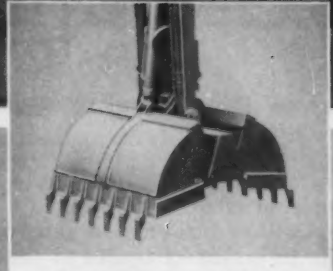


Big Mo 400 with 10′ Backhoe



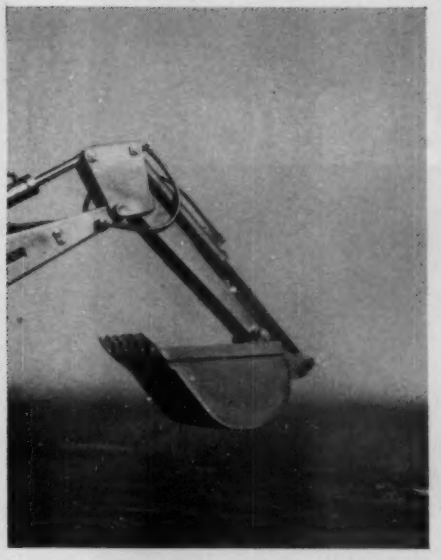
Big Mo 500's new, 400-lbs.-heavier front end . . . exclusive new ⅞ yd. loader!

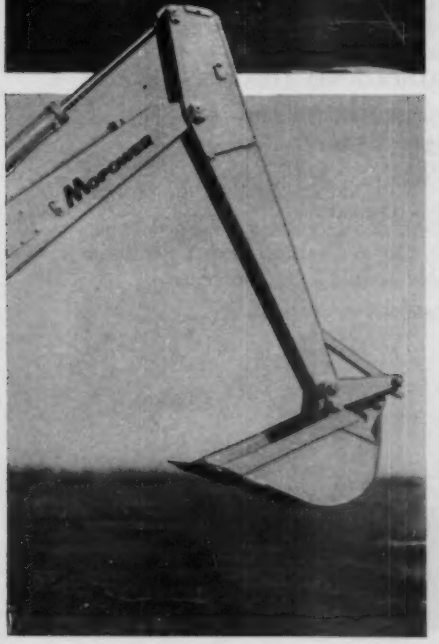
Big Mo 500 with 13′ Backhoe



New Mopower Hydro-Clam . . . available on the 13′ and 15′ backhoes!

Big Mo 500 with 15′ Backhoe





PICK YOUR DEPTH... 10, 13, 15 FEET!

Only the new line of Big Mo's give you this choice of backhoes . . . plus exclusive new ⅞ yard loaders, new 400-lbs.-heavier front ends!

Now, new Mopower *flexibility!* The Big Mo 500 available with 13′ or 15′ backhoe! The Big Mo 400 with 10′ or 13′ backhoe!

Mopower lets you pick the muscles to match your jobs! Just take a good look at that Big Mo 500 with its exclusive new *15′* backhoe—the longest, deepest digging backhoe you can get! Then, read on! There's more! Remarkable new "500" features like the exclusive new ⅞ yd. loader with 6000 lbs. of brute breakout force; a new self-leveling mechanism that levels and holds each bite automatically; a new front end with 400 lbs. of added weight for surer balance; and a new hydraulic system for high speed operating of the bigger backhoe and loader.

These new advances, along with the 500's no-clutching shuttle reverse and its powerful Motec-built engine, give it the muscle and mobility needed for your toughest jobs.

The new Big Mo 400 is no lightweight, either. Its new, heavy duty front axle is 226 pounds heavier for better balance in backhoe work. The loader holds ⅝ths of a yd. *struck*. And remember, the 400 is available with a 10′ *or* a 13′ backhoe. In addition, it has the same rugged Motec-built engine as its big brother, the 500. And the low-priced 400 is available *without* the backhoe or loader . . . for mowing, drawbar work, *wherever* you can put this versatile wheeler to work.

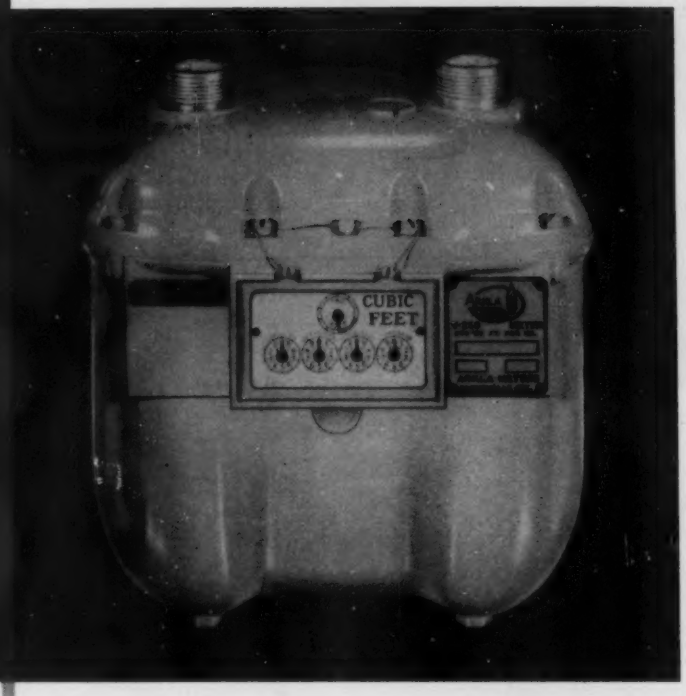
Check *all* the features of the new Big Mo 500 and 400 at your Mopower dealer's *today*. Then, *pick the muscles to match your jobs!*

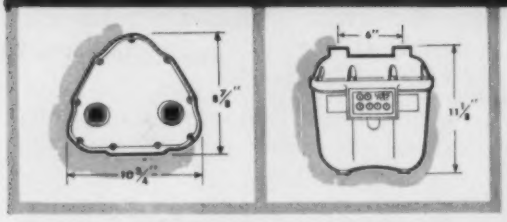
Mopower's mighty Motrac Crawler . . . with new 40° bucket rollback for "healthier" bites, new 50° dumping angle—the maximum available, and new, shorter lift time and dump time (6½ seconds). Test drive it at your Mopower dealer's *today*.

MOPOWER

Construction Equipment • Division of MOTEC INDUSTRIES

THE ARKLA V 250 GAS METER





Dimensions: The Arkla V250 Gas Meter weighs less and is smaller than any other 250 cu. ft./hr. gas meter.

A NEW, COMPACT, ACCURATE "CASH REGISTER" FOR THE GAS INDUSTRY!

EXCELLENT ENGINEERING AND DESIGN of this gas meter, first of a new, modern line, are evident in its light weight and compactness that make the Arkla V250 Gas Meter easy to install . . . fewer moving parts reduce maintenance . . . accuracy of the Arkla V250 Gas Meter makes it a welcome "cash register" for the gas industry.

Order ARKLA V250 GAS METERS TODAY. *(Other models available soon.) For further information, write or call us, or ask your Arkla-Reynolds Gas Regulator representative.*

ARKLA

WRITE OR CALL:

ARKLA METERS, Russellville, Ark. PH. WOodruff 7-2550

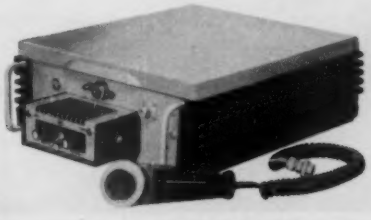
A Division of Arkla Air Conditioning Corporation

RCA "LD" 2-way radio has the guts to stand up to the toughest jobs!

There are rugged places where men, trucks and 2-way radios have to go, and each has to be a proven, reliable performer. In 2-way radio, this means quality must be built-in to take the gaff—quality such as only the leader in radio and electronics can offer—in the new RCA "LD" (Low battery Drain). Quality and price are combined in this dependable RCA equipment to give you the very best performance at the lowest cost. Use it on the roughest roads—Security Sealed Circuits are your assurance it can take it. Leave the radio on when your vehicle engine is turned off—battery drain is negligible—transistors are used in circuits where they have been proven to be most dependable.

It took experience and daring to bring you today's RCA 2-Way Radios. It meant discarding preconceived notions about circuits and redesigning with transistors in key places for reliability with economy. And it involved engineering a host of other advanced features to assure fine message intelligibility, and long component life at moderate cost.

Your RCA Communications Specialist will be glad to show you why the "LD", dollar for dollar, feature for feature, is today's greatest 2-way radio value. Or send coupon for further facts.



RCA

The Most Trusted Name in Radio

RADIO CORPORATION OF AMERICA

RADIO CORPORATION OF AMERICA
Telecommunication Center, Dept. W-180
Meadow Lands, Pa.

☐ Please send me FREE literature on the new RCA Transistorized Mobile Radio.

☐ Have RCA Communications Specialist contact me and explain why this is today's best value in 2-way radio.

NAME _____ TITLE _____

COMPANY _____

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ADDRESS _____ PHONE _____

CITY _____ ZONE _____ STATE _____

Bristol Dynamaster* Computer is easy to adjust for constant factors or other system parameters. Small instruments are miniature Bristol Metameter telemeters; those at engineer's right are famous Bristol Series 500's.

** T. M. Reg. U. S. Pat. Off.*

Modern telemetering computers can pay off for "short hauls" as well as long

■ **Problem:** Purchased natural gas flows only a short distance to consumers in the distribution system of the prominent Indiana utility whose dispatching center is shown below.

As a result, there isn't much capacitance in the lines to absorb the shock of sudden consumer demands. During peak demand periods, consumption increases are reflected almost instantaneously in lowered pipe line pressures, necessitating extremely close dispatcher control to provide proper service—as well as to avoid contract penalties.

■ **Solution:** Bristol telemetering and automatic computing solved the problem. Metameter* telemeters and Dynamaster* flow computers give the gas dispatcher complete, continuous, digested flow data almost instantly—allowing immediate adjustments to assure optimum service under all conditions.

■ **"Fail-Safe" Operation** is provided by the Bristol Meta-Slidewire computing system. It is designed to insure against loss of measurement in the rare event that a metering component should fail.

■ **Bristol Offers a Complete Service** in telemetering, gas flow computing, data-logging and instrumentation for gas, oil, and petroleum products pipe lines and gas distribution systems. Write for full details on how Bristol engineers can help solve your particular problems:

The Bristol Company, 119 Bristol Road, Waterbury 20, Conn.
A Subsidiary of American Chain & Cable Company, Inc. 1.B

Bristol flow computing solves low-capacitance problem for gas distributor

ACCO

BRISTOL ... leader in instrumentation for the gas industry

AUTOMATIC CONTROLLING, RECORDING, LOGGING AND TELEMETERING INSTRUMENTS

CASE W-3 backhoe-loader works wherever you need it--any time of the year!

With both direct drive and torque-converter drive, the W-3 helps you step up schedules, cut costs, avoid delays due to bad weather

The 52 hp Case W-3 is the only unit in its work range offering the travel speed and fuel economy of direct drive PLUS the bonus power, traction and operating ease of torque-converter drive.

Fast travel to *any* job

With the W-3, you travel hard surfaces in direct drive at speeds to 19 mph. To move cross-country; ease through mud; negotiate snow, slippery slopes, move large loads — you use torque-converter drive that instantly, automatically provides the correct speed-to-power ratio for the footing.

Faster work on *every* job

The W-3 with torque-converter drive gives you an infinite number of speeds down to 0 mph — without clutching, shifting or stalling. On loader work, this cuts wheel slippage, increases traction, enables you to move more material. With the torque converter you can move the backhoe in, on and off the job — despite hub-deep mud. You can work jobs a direct drive hoe couldn't reach! For backfilling or loading, the W-3 torque converter delivers up to twice the output torque you'd get with similarly sized, direct drive units. This bonus power, plus the W-3's traction advantages, pays off in faster, smoother loading under good conditions and ability to keep working efficiently despite rain-soaked or frozen materials and bad footing.

Built to take sustained hard usage

The W-3 features Case-built gasoline or diesel engines proved in millions of hours of field use... 7000-lb capacity front axle... extra-heavy wheel bearings... rugged, box-section loader frame and arms... and a special, alloy-steel backhoe tower proved under the severest conditions.

But see the W-3 and judge for yourself how it solves your specific problems. Ask your Case Industrial Dealer to arrange for a demonstration, show you why buying on price alone is a false economy. Or write for literature to Dept. F1391, J. I. Case Co., Racine, Wis.

CASE®

J. I. CASE CO., RACINE, WIS.

Case W-3 backhoe digs to depth of 14 ft, offers 18 to 38-inch buckets. Loader is available with 15-cu ft to 1-cu yd buckets. Tractor features power steer, shuttle transmission with split-second forward-reverse shift. Optional attachments include blade, crane boom, forks, mowers, hitches and pto.

Also LOW-COST* CRAWLERS FOR BACKFILLING, GRADING

J. I. Case offers two easily transportable, highly productive power-angling dozers with "on-the-go" blade setting for high-speed follow-up behind trenchers, for grading and similar work.

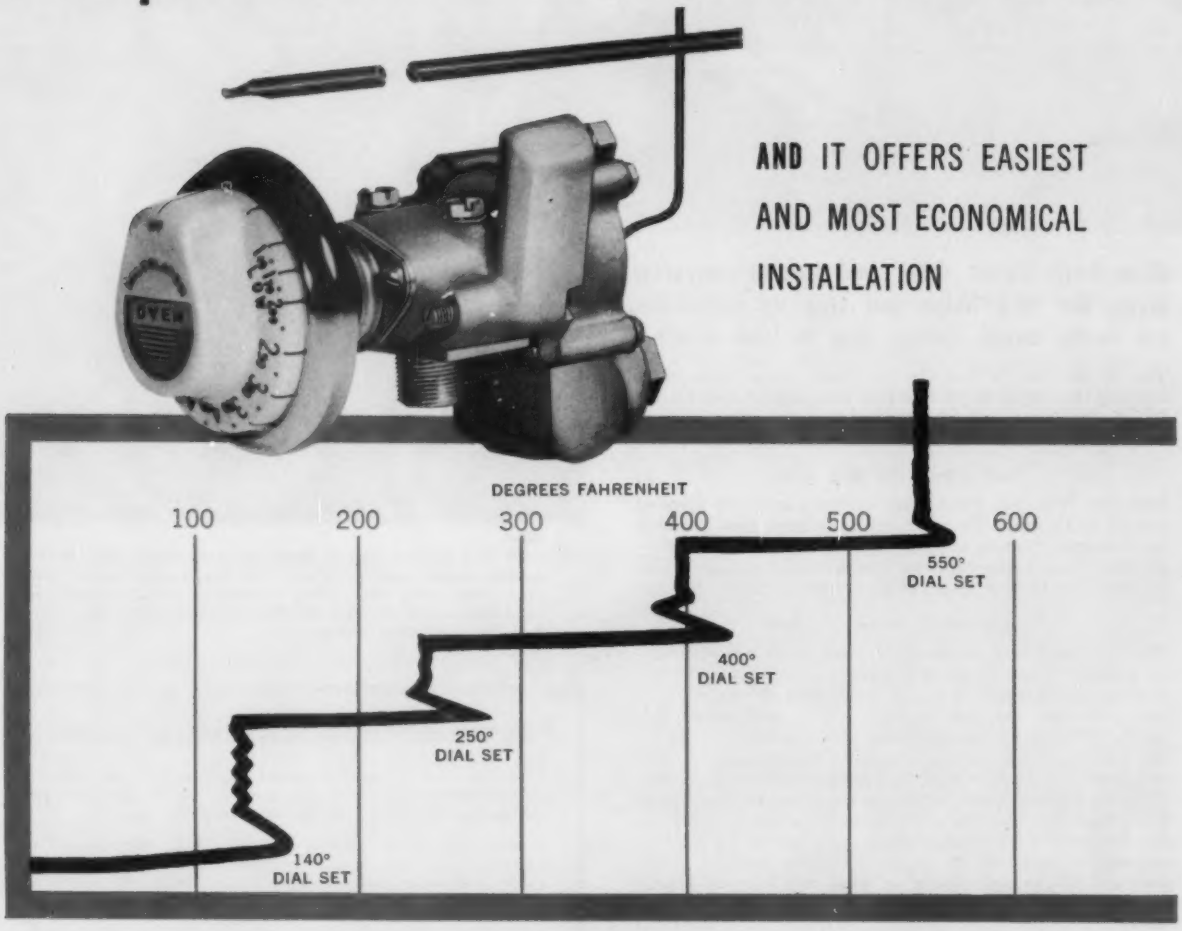
Model 420 — 42 hp gasoline or 40 hp diesel. Also available as power-tilting or straight dozer... ¾-yd loader... backhoe-loader combination — with other equipment including sideboom and pallet or log forks.

Model 600 — 62 hp gasoline or diesel with exclusive Terramatic® transmission. Also available as power-tilting or straight dozer, 1-yd loader or loader-backhoe combination — with other equipment including scarifier, sideboom, winch, pto, and pallet or log forks.

*Prices start at $5466.50, factory list, for gasoline-powered Model 420 power-angling dozer.

CT-DB-572

Look how accurately the new Wilcolator XL controls oven temperature even down to 140°



AND IT OFFERS EASIEST AND MOST ECONOMICAL INSTALLATION

TEMPERATURE RANGE:

140-550°F (60-288°C), plus broil

AGA RATING, BTU/HR:

Manufactured gas	49,000
Natural gas	72,500
LP gas	154,000

Below 325°F the XL initiates a cycling action for temperature control by shutting off the burner pilot. This in turn closes the safety pilot. When the oven has cooled and more heat is required, the XL again admits gas to the burner pilot, which is ignited by the standby pilot. This opens the safety pilot and permits gas to flow to the main burner. This system achieves extremely close temperature control.

WILCOLATOR AR-12 SAFETY PILOT

Where low-temperature is not required, the low pilot gas consumption of the AR-12 makes it an economical non-cyclic automatic pilot.

XL FEATURES

- Easily incorporated into any gas range—compact, with choice of four different outlet positions
- Special fittings and brackets unnecessary, minimum tubing, simplicity of manifold design
- Valve and seat, constructed of corrosion-resistant aluminum alloy, provide smooth, low-torque turning action at both high and low temperatures
- Stainless steel diaphragm
- Calibration, bypass and pilot adjustments all made from front of stove
- Flange bolts and lockwashers supplied preassembled for faster installation
- Flange plate recesses into thermostat body, pre-positioning the thermostat with respect to flange plate for quick, accurate assembly
- Snap-on dial and bezel

The most compact pilot on the market today, the AR-12 can be used in connection with the Wilcolator low-temperature control or with a Wilcolator XC standard oven control. The AR-12 features ease of mounting, faster valve action, high-speed shutoff and the lowest Btu consumption for both primary and secondary pilots. There are three choices of inlet, and the body can be mounted in any position. Faster valve action, high-speed shutoff, high ambient rating, non-aerated lintless pilot, and universal orifice are other features. When used as a straight safety pilot in combination with the Wilcolator XC, there is no waiting for main burner ignition. Write for the new Wilcolator data sheet covering both these products.

Thermostats for Every Heating and Cooling Application

THE Wilcolator COMPANY

THE WILCOLATOR COMPANY
1001 NEWARK AVE., ELIZABETH, N. J.

Subsidiaries and/or affiliates in
Canada, Great Britain, Italy, West Germany, and Australia

NEMA

NO PLACE FOR SISSIES

MOTOROLA 2-WAY RADIO TAKES A BEATING... because it's built to take it!

A 2-way radio is a precise, complex electronic instrument. But unless it is *rugged* too—unless it can shrug off jolts and vibration and come back for more—it just can't go to work in the oil fields.

Motorola engineers *design* a radio to take it. Extensive field tests *make sure* it's no sissy—Motorola literally beats the "bugs" out. Then a tough, rigid quality control setup *keeps* them out.

This kind of consistent leadership in research, development and engineering has led to a radio that will stand up to rough treatment and still deliver dependable service—day after day. You'll see *why* when you check with your local Motorola representative—he'll give you all the facts. Write: Dept. AGA121.

MOTOROLA 2-WAY RADIO

Motorola Communications & Electronics, Inc., 4501 Augusta Blvd., Chicago 51, Illinois • A Subsidiary of Motorola Inc.

IN ROCKY SOIL—IN TIGHT QUARTERS, TOO—NOTHING DIGS TRENCH LIKE A CLEVELAND J

DEPENDABLE TRENCH PRODUCTION in conditions like these takes a trencher that's built for tough digging, yet no bigger than it has to be, and able to dig up close to, and sneak by, trees, poles, fences and other side-obstructions. That's an exact description in every respect of a Cleveland J Trencher. On tough jobs or easy, in all soils and job conditions, Cleveland J's *dig more trench . . . in more places . . . at less cost . . .* because of Cleveland features like these:

- **4 digging-wheel speeds, over 30 positive crawler digging speeds—the *right* combination of power and speed for every soil and condition.**
- **Ample power—big 330-plus-cubic-inch engine.**
- ***The world's finest trencher crawlers*—1,000-hour lubricated, 100% anti-friction-bearing-mounted track with dual drive and support.**
- **Big 16" x 3" hydraulic steering brakes.**
- **V-conveyor with automatic side-to-side shifting —no slow-down to sneak by side obstructions.**
- **Conveyor reversal and speeds up to 1,000 FPM with pulley-enclosed, dual hydraulic drive.**
- **Positive, fast, full-range boom hoist—keeps accurate grade, speeds set-in time around underground obstructions.**
- **Full job-visibility for the operator.**
- **100% control of every operation at the operator's seat.**

There's a Cleveland J for every type and size of trench, from 13 to 30 inches wide, down to 7 feet deep. Check them now with your distributor.

CLEVELAND TRENCHER

THE CLEVELAND TRENCHER CO., 20100 ST. CLAIR AVE., CLEVELAND 17, OHIO

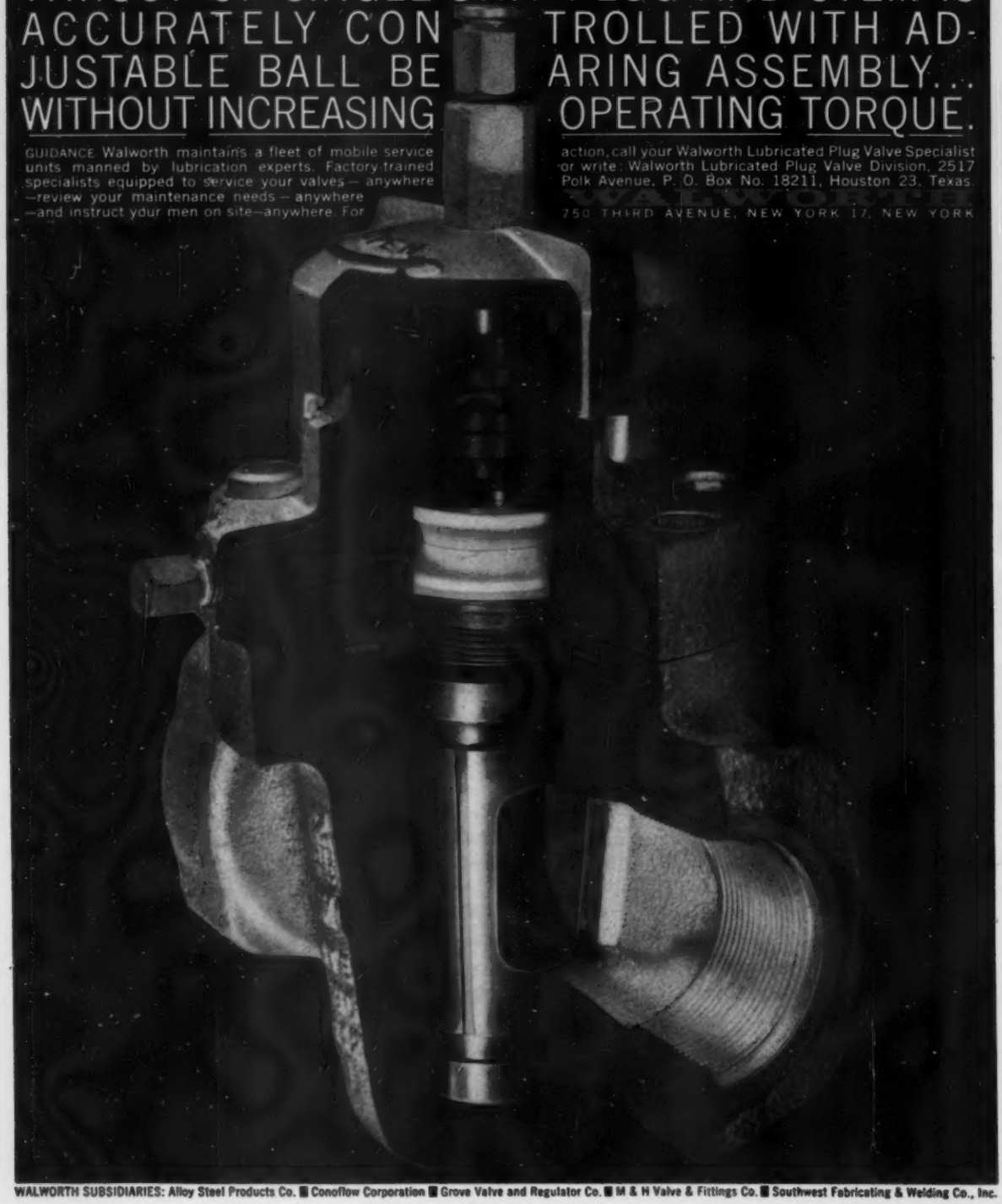
THIS BALL BEARING RUNS THE ROLL IN ROLOTORK

MAKES THIS THE EASIEST OPERATING HIGH PRESSURE LUBRICATED PLUG VALVE YOU CAN FIND. UP-THRUST OF SINGLE-UNIT PLUG AND STEM IS ACCURATELY CONTROLLED WITH ADJUSTABLE BALL BEARING ASSEMBLY... WITHOUT INCREASING OPERATING TORQUE.

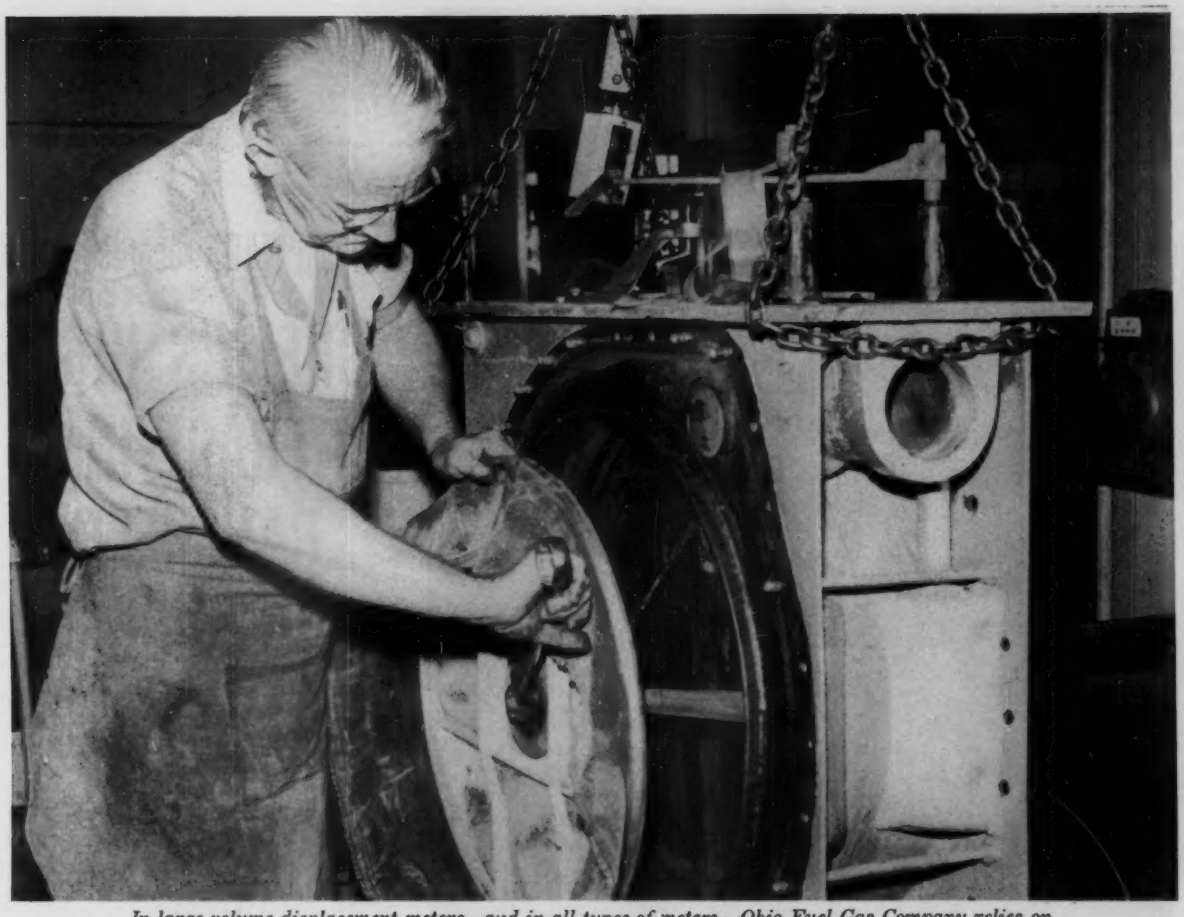
GUIDANCE. Walworth maintains a fleet of mobile service units manned by lubrication experts. Factory-trained specialists equipped to service your valves — anywhere — review your maintenance needs — anywhere — and instruct your men on site — anywhere. For action, call your Walworth Lubricated Plug Valve Specialist or write: Walworth Lubricated Plug Valve Division, 2517 Polk Avenue, P. O. Box No. 18211, Houston 23, Texas.

WALWORTH

750 THIRD AVENUE, NEW YORK 17, NEW YORK



WALWORTH SUBSIDIARIES: Alloy Steel Products Co. ■ Conoflow Corporation ■ Grove Valve and Regulator Co. ■ M & H Valve & Fittings Co. ■ Southwest Fabricating & Welding Co., Inc.



In large volume displacement meters—and in all types of meters—Ohio Fuel Gas Company relies on Reeves-Vulcan synthetic diaphragms for greater dependence, longer life and lower maintenance costs.

"We greatly reduced P.D. meter maintenance with Reeves-Vulcan synthetic diaphragms"

M. P. DeBaets, General Superintendent Gas-Measurement Department, Ohio Fuel Gas Company, Columbus, Ohio

"The frequent replacement of leather diaphragms required in large-volume, positive-displacement meters on gas wells," says Mr. DeBaets of Ohio Fuel Gas, "was, at one time, one of our major maintenance problems."

Problem: "When we were using leather diaphragms, the impurities in the wellhead gas would wash the oil out of the diaphragms, and diaphragms had to be replaced frequently. And cold weather aggravated the situation."

Solution: "About 6 years ago, we changed to Reeves-Vulcan synthetic diaphragms for these meters, as well as for industrial and domestic meters. Our experience shows that Reeves-Vulcan synthetic diaphragms last longer... withstand wellhead gas impurities...operate better at low temperatures... are not affected by odorants. What's more, since they require no oil, maintenance schedules have been extended."

Since changing to Reeves-Vulcan synthetic diaphragms, Ohio Fuel Gas reports substantial savings through reduction in meter maintenance and testings, and a much lower rate of diaphragm replacement. How about *your* metering efficiency?

There's a Reeves-Vulcan diaphragm for practically every type of gas meter made. Both molded and crimped styles are available in any volume. Order Reeves-Vulcan synthetic diaphragms from leading manufacturers or directly from:

REEVES VULCAN

Reeves Brothers, Inc., Vulcan Rubber Products Division
1071 Avenue of the Americas · New York 18, New York

Official NADA records* prove

CHEVY'S HIGH TRADE-IN CAN HELP CUT YOUR FLEET COSTS!

Besides Chevrolet's low initial price and low operating cost, you can count on still another big saving at trade-in time. And you don't have to take our word for it. Check the official National Automobile Dealers Association records for yourself and see how Chevies *consistently* bring higher trade-in return than any other car in their field. Why? Because more people want Chevrolets than any other car. It's this greater demand (on both the new and used car markets) that keeps Chevy's resale value *up* to help keep your fleet costs *down*. And while you're at it, check your dealer on all the people-pleasing improvements in the new Chevrolets that not only make them better cars for business—but a better bet for higher trade-in in the years to come.

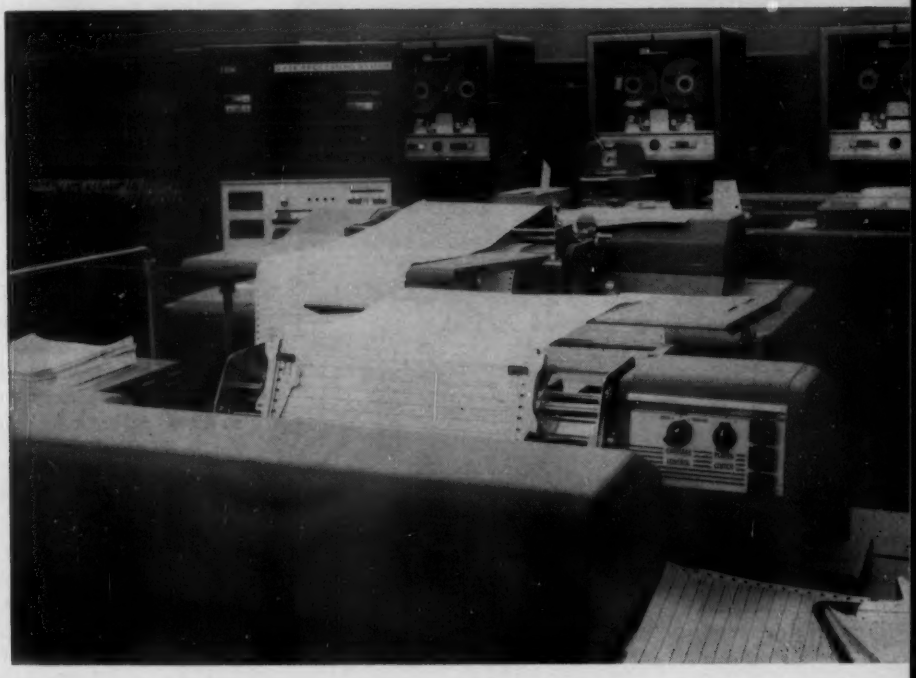
...Chevrolet Division of General Motors, Detroit 2, Michigan.

CHEVROLET

*Based on prices in the National Automobile Dealers Association 1961 USED CAR GUIDE, recent-model Chevrolets are now bringing a higher percentage of their original price than any other full-sized car in their field.

GAS

JUNE 1961



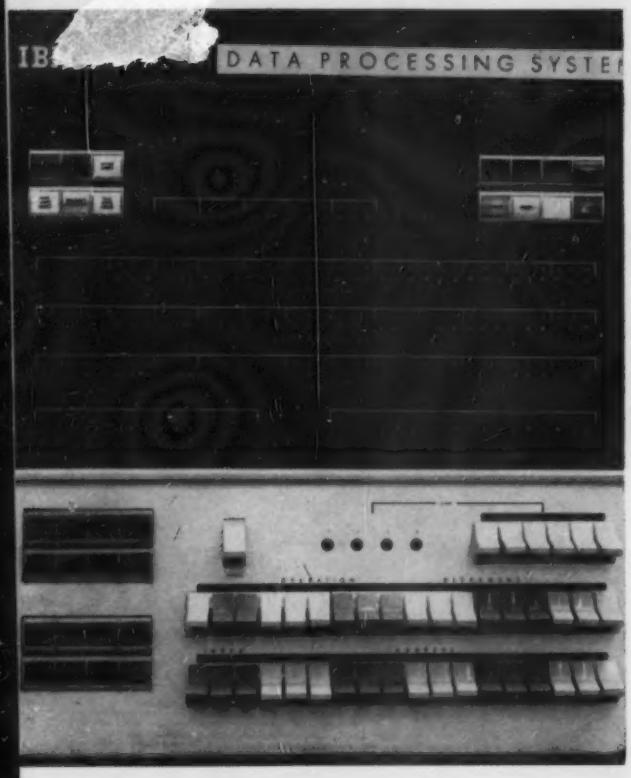
How Southern Union developed a

New program for high-speed digital computers

THE rapid expansion of the gas industry in the last decade and the relative scarcity of qualified technical personnel have resulted in the development of better engineering tools. Continued development in that direction is necessary as the industry looks to the future.

We have seen a 15-year growth in the gas industry which has been greater than at any other time in the history of the industry. The increased population in most areas of the country and the competitive position of natural gas as a fuel have resulted in new load peaks each year. This expansion and the move to suburbia require construction of new facilities at an increasing rate. Many utilities have found the distribution systems of the 20's and 30's inadequate to

By A. G. PRASIL and R. V. JEBAVY, Southern Union Gas Co., Dallas



Many new techniques are possible because of the speed of the computer.

meet today's demand and have had to provide reinforcement to these systems.

The increase in the industry's annual construction budget is not due wholly to the need for increase facilities. As the need for new construction has grown, so also has the cost of labor and materials. Plant expansions have increased the demand for investor's dollars and the cost of money has risen accordingly. Each year the investment in plant per customer has grown larger. The problem of adequate rate of return at existing gas rates is increasing.

If gas is to remain competitive, additional effort is required in the area of cost control. One of the most easily controlled areas of expenses is that of capital expenditure. The capital budget and the work order can be closely scrutinized to produce the maximum return per dollar invested. To be worthwhile, the examination of the construction program must be based on both system analysis and operating reports. System analysis requires a considerable amount of engineering time. While many utilities have been preparing long range plans and developing annual budgets on the basis of system studies, there is also a need to determine the effect of unexpected additions and changes which are bound to occur. Much of this work has been neglected for lack of engineering time.

Just as construction costs have increased, the cost of engineering services has also risen. Increased demands in all industries have reduced the supply of technical personnel available. Therefore, if additional effort is to be put into a cost control program, reduction of required engineering time is essential. One of the most logical methods of achieving this goal is through simplification of the engineer's task by greater use of available mechanical tools. The process of developing new methods and improving existing routines for the digital computer is one of these available tools.

The engineering staff can generally be divided into two or three groups. There are those on a professional level. By education and experience, this group is best trained for design and decision. This is the group responsible for the engineering aspect of cost control. There is also a clerical group required for maintenance of the professional personnel. This group is generally charged with the responsibility for records, drawings and providing much of the information required by engineers for studies and planning. In many organizations there is a third group with such as engineering assistants or engineers in training. To meet rising costs by full utilization of manpower, as much preliminary work as possible must be shifted to these latter two groups leaving the engineer free for creativity.

DEVELOPMENT OF NEW ROUTINE

Southern Union Gas Co. has been aware of this need to continually improve the allocation of engineering time. The above-average growth of the company's service area presents a continuing engineering problem. Over-all master plans and system improvement plans have been developed, using digital computer techniques. Engineering personnel have not been fully satisfied, however, with the present methods used for these calculations. It has been felt that new programs were desirable to further reduce engineering time and to make comprehensive studies of the effect of changes in plans economical.

With this in mind, Southern Union engineers met with representatives of local computer consultants to utilize the latest computer developments and to refine current programs. Several requirements had to be met for any new program to prove more valuable than those already available. The basic necessity was to meet the standards of these available programs. The program had to be flexible enough to duplicate the various operating conditions which are encountered in the distribution system, such as different pressures at each of the sources feeding the system. The program had to be simple and, above all, reliable.

The main objective in the development of a new program was the reduction of professional time required to perform a network analysis. This had to be done without increasing clerical time out of proportion. Two areas of possible improvement were suggested. Since the calculation of the pipe resistance coefficients is a mathematical operation, it was felt that this could be performed in the routine. Time could also be saved if the initial assumption of flow could be a part of the program. It was hoped that the machine calculations could be completed without the presence of the project engineer and that minor

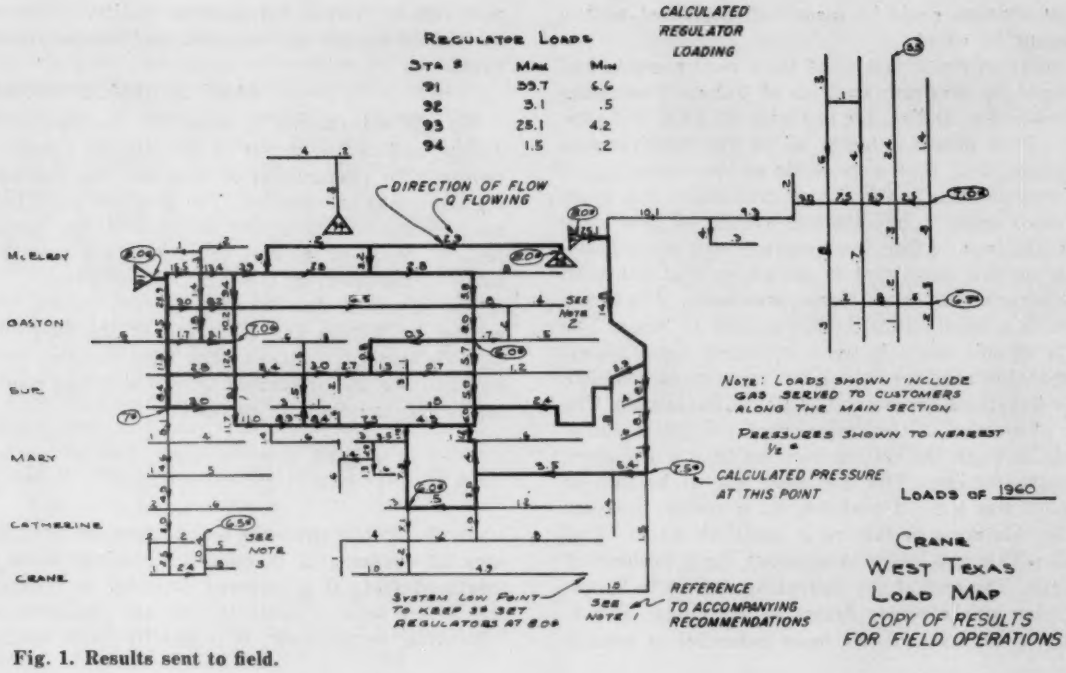
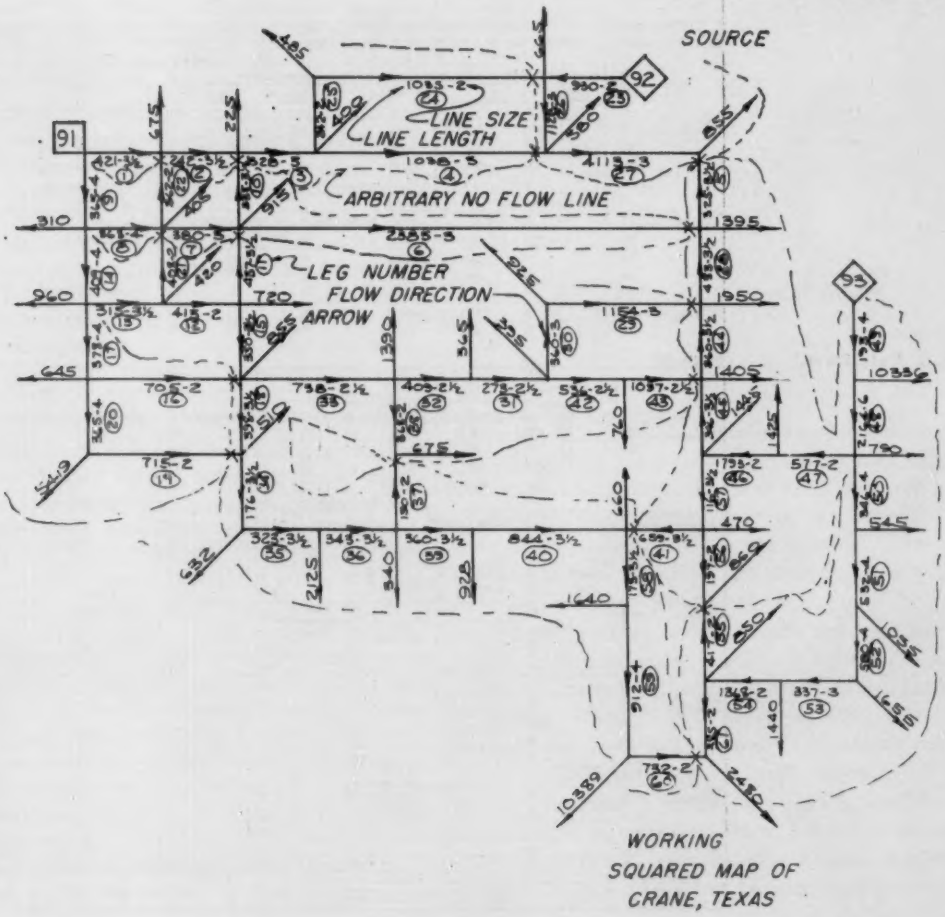


Fig. 1. Results sent to field.

Fig. 2. Initial working map.



system changes could be made and evaluated with a minimum of effort.

A program which met all of these requirements was developed by program analysis of Temco Electronics & Missiles Co., Dallas, for use with its IBM 704 computer. This program meets all of the requirements and suggestions that were made at the beginning of the development. The first test calculation was made by Temco using a hypothetical system of two loops and eight legs. After the program was proved successful on this small system, an analysis of Southern Union's system in Crane, Texas, was made. The Crane system is a small one with 61 legs and 19 loops. The results of this analysis were extremely satisfactory. The machine requires only a few minutes to complete the 20 iterations necessary to balance the system. The error of closure at the majority of the joints cumulatively through the system was less than a difference of squares of one. The maximum out of balance at any joint was a Δ (P^2) of 0.8. At a system pressure of 3 lb, this error of closure is less than 0.1 lb. This is well within the limits of accuracy for a problem of this type. The cost of the computing service to Southern Union was a minor factor in the study. Subsequently, a second analysis, more extensive in nature, was run by Temco for another utility. This analysis proved equally as successful and comparatively as rapid.

BASIS OF TEMCO PROGRAM

We will not attempt to detail the mechanics of the Temco routine but rather to indicate the simple steps required for preparation of data and the possibilities for the use of the routine. The program itself utilizes machine calculation of the modified Hardy Cross approach. Many of its new techniques are possible because of the speed of the IBM 704 computer.

The improved flow formula, $\Delta\ (P^2) = KQ^{1.8}$, described by Wilson and Ellington of the Institute of Gas Technology, Chicago, was used for the routine. Substituting the prescribed value for K and readjusting terms, the formula becomes:

$$\Delta\ (P^2) = \left[\frac{Q^{1.8}\ L}{D^{4.89}}\right] \left[2.088\ \frac{P_b^{1.80}}{T_b}\ G^{0.80}\ u^{0.20}\ Tave\right]$$

where $\Delta\ (P^2)$ is pressure drop expressed as a difference of squares; Q is quantity flowing; L is pipe length in feet; D is internal diameter in inches; P_b and T_b are base pressure in psia and temperature in ° Rankine, respectively; G is gravity; u is viscosity;

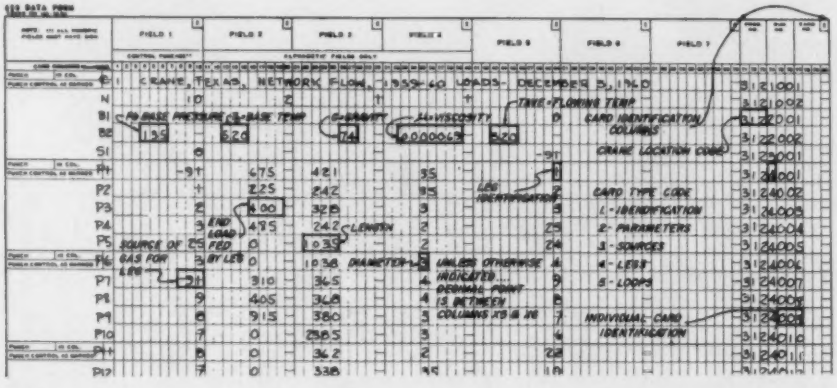
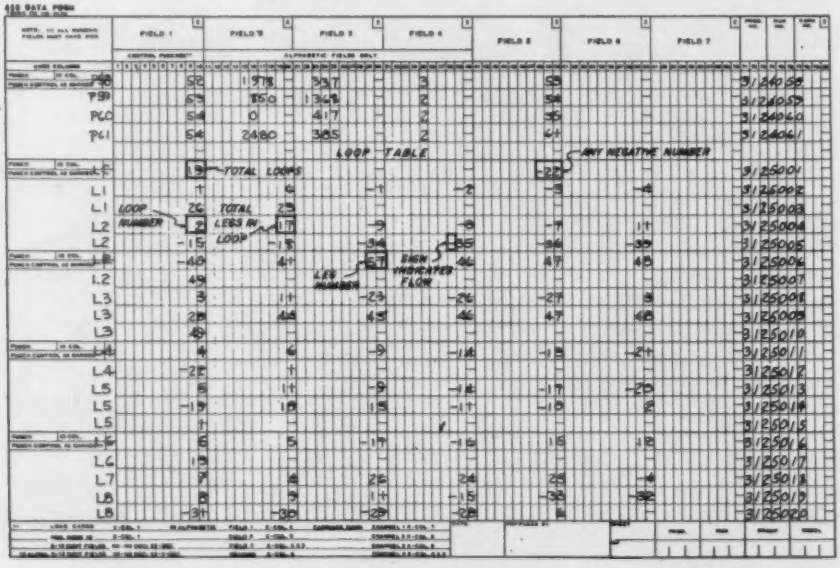


Fig. 3. Data form.



and Tave is the flowing temperature of ° Rankine. The second term of the flow equation represents parameters which will be constant through the solution of the problem. The first term represents parameter which will vary in each pipe section. The constant values are committed to machine memory at the beginning of the solution and used to compute K for each pipe section as it is introduced. If necessary, however, the so-called constant parameters can be changed in any one or more legs.

The Temco routine is limited to a total of 800 pipes and sources and a maximum of 2204 loop table entries. The routine will automatically stop itself when an iteration indicates a zero flow correction is more than half of the legs in the system or when the number of iterations reaches 64. Because of the rapidity of each iteration, it is not practical to stop and print out the results until the routine is completed, unless it appears by time estimates that the solution is not closing. There are also certain built-in checks on the leg information as it is fed into the memory section of the computer.

USE OF THE PROGRAM

Preparation of the data for the Temco routine can be divided into two categories by the degree of skill required. Basic preparation is much the same as that required for any system analysis. Conditions of the problem and load data should be assembled by the project engineer. We prepare a small map of the area indicating only the distribution system under study as it exists geographically. The loads are assigned by blocks throughout the entire system and shown on a work copy of the map. Loads on dead ended laterals and feeders are carried forward until a junction is made with the looped system. Another copy of this map is used to convey results of the study to the field *(Fig. 1)*.

The usual squared working map of the looped portion of the system is made to assist in assembling data *(Fig. 2)*. The loads through the system are applied at the junctions of applicable legs. In addition to the loads, the map indicates the size and length of each leg. At this time the legs and loops are numbered. Loops should be numbered in numerical sequence beginning at one. The assignment of leg numbers is unimportant except that duplications must be avoided. A further step is necessary in the preparation of the map to permit completion of data forms by clerical personnel. In order to provide the data in the form required for the computer to make the initial flow assumption it is necessary to cut all of the loops by arbitrary no flow lines. This has the effect of reducing the system to a number of laterals or "fingers." Each lateral can have any number of branches as no loops are retained. There is much benefit to be gained if the "no flow" lines are established in such a manner that source or regulator feed areas are established. The assumed direction of flow for each leg in these fingers should also be noted on the map. After some training this map preparation can be undertaken by clerical personnel.

The final step in the preparation of information for the machine is the tabulation of data for the key-

FINAL FLOW TABLE

PIPE	FLOW	K	H=DEL(PP)
-91.	34.36299849	0.	-0.
1.	15.51847148	0.11414041	15.88427818
2.	13.44911170	0.06561040	-7.05701756
3.	3.85171875	0.18636987	-2.11132023
25.	0.64867413	0.96284239	0.44177707
24.	0.16367417	4.11794162	0.15843277
4.	2.80304477	0.58979245	-3.77079758
9.	23.86484838	0.05213013	-15.76179888
8.	9.03506148	0.05255859	-2.76261032
7.	8.22427773	0.21591631	9.58211398
6.	6.45851052	1.35515894	-38.92498970
22.	-1.39436010	1.44028489	2.62013200
10.	-9.37239385	0.09163766	-5.14523226
14.	14.51978540	0.05841430	-7.21186423
13.	1.72385150	0.08540197	0.22759750
12.	3.10399610	1.65115534	12.68370020
15.	12.60715675	0.09489107	9.08523595
33.	5.35734999	1.00606999	20.64137387
32.	3.03799450	0.55756453	4.12052298
31.	2.67259449	0.37216410	2.18439767
42.	1.48925646	0.73069582	1.49652173
43.	0.72925641	1.41367830	0.80082526
38.	0.54235527	1.46415702	-0.48673768
30.	0.78873799	0.20455229	0.13344016
29.	-0.31826200	0.65570374	-0.08350496
11.	-10.22316062	0.11847828	7.77843142
21.	-1.80014472	1.62330452	4.67684788
17.	11.83593297	0.05398681	-4.61373013
20.	8.43603134	0.05213013	-2.42179555
19.	3.01702997	2.84476161	-20.76295614
16.	2.75490153	2.80497473	-17.38280821
18.	9.14970851	0.10790471	5.80194288
34.	11.65673983	0.04771665	-3.96742618
35.	11.02473998	0.08757091	-6.58601892
36.	8.89973998	0.09299325	-4.75697362
39.	8.42709577	0.09760225	-4.52564234
40.	7.49909502	0.22882305	-8.60034466
58.	10.99159849	0.04690330	-3.50843138
59.	9.35159850	0.13025390	-7.28425795
60.	-0.50640202	2.91239929	0.85573986
37.	0.13264467	0.59680313	0.01572851
-92.	2.09999996	0.	-0.
23.	2.93206477	3.70017943	25.65280771
26.	2.43073881	0.64093452	3.17058864
27.	4.65378332	2.33760997	37.21444941
-93.	30.97299838	0.	-0.
49.	25.12061381	0.02756469	9.12867177
48.	14.78461504	0.04413825	5.62954193
47.	3.85081747	2.29570273	25.99624252
46.	2.42581770	7.13378680	35.16124678
45.	-5.03626856	0.09360660	1.72199897
44.	-5.71203202	0.09760225	-2.24741435
28.	-7.98029367	0.11739381	-4.93491101
5.	-3.79878363	0.08811314	0.97364543
57.	6.01710612	0.03144961	0.79526687
56.	1.23760313	0.78380145	1.15040879
41.	4.30950326	0.17866634	2.47748718
50.	8.69179845	0.04941650	2.42252976
51.	8.14679849	0.07596144	3.31500217
52.	7.09179860	0.08283691	2.81569150
53.	5.43679869	0.19148367	4.03412360
54.	3.45879877	5.44284457	50.80317163
55.	-0.37760317	1.65911271	0.28743443
61.	2.98640183	1.53179471	10.97658479

Fig. 4. Printout of results.

punchers. This is a purely routine operation where information is transferred from the map to a standard 7-field, 80-column data form *(Fig. 3)*. One line of the form is used for each card to be punched. There are five card types used in the routine. They form the problem identification, the demand table and the loop table. The cards required are:

1. **Identification**—two cards are used per problem. The first carries any word or digit identification up to 72 characters. We use town name, system designation, load criteria—such as 1961 loads, and the date the form is prepared. The second card carries any numerical code up to 40 digits.

2. **Parameter cards**—one card is used to carry the constant parameters—base pressure, base temperature, gravity, viscosity and flowing temperature in that order. The other card precedes the parameter

card and acts as a signal to the machine. Parameters can be changed by inserting new parameter cards at the proper point in the demand table.

3. **Source cards**—these cards identify the sources or regulators in the system. One is required for each source. The second field indicates any pressure differential between the source and the source of lowest pressure in the system and the fifth field carries the source identification number. The first, third and fourth fields remain blank.

4. **Pipe card**—these cards identify legs on the system—Field One indicates the number of the pipe or source that directly supplies this pipe. This supply pipe or source must be previously described by a pipe or source card. All pipes initially supplied by one source must be described before a new source is introduced. Fields Two through Five indicate demand at the downstream end of the pipe section, length, diameter and identification number in that order. In many cases, the elimination of loops in the system during the mapping step will result in legs carrying no load during the initial iteration. A demand of zero should be listed on the cards for these legs.

5. **Loop cards**—these cards describe the loops in the system. All of the simple loops must be described. Enough redundant loops must be described to list all of the sources. Additional loops for more rapid convergence can be added as desired. Loop cards carry the loop number in Field One and the number of legs in the loop in Field Two. Fields Three through Six designate the legs in each loop. If more than four legs are contained in a loop, additional cards are used. These additional cards use all six fields for leg description. The direction of flow of each leg in the loop must be indicated by a minus sign if the flow is counterclock-wise. No sign indicates clock-wise flow. If flow arrows are used on the map the tabulator will find sign designation fairly simple.

When the data sheets have been prepared the problem is ready for machine calculation. Since the majority of this preparation has been a routine manual operation checking is relatively simple.

Authors Prasil (right), Jebavy, Southern Union Gas Co.

DATA RESULTS

The computer calculations are done for Southern Union by Temco on a contract basis. While Southern Union engineers were present during the trial run on the Crane system, it is felt that no particular advantage is gained by their presence. All of the required information for the operation can be mailed to Temco and the completed study returned in the same manner. Should the necessity arise, delivery and pickup can be made personally. Once a deck has been developed for a system it will be practical to describe minor changes over the telephone.

The results of the calculation are printed out to show the leg identification, final flow, the computed value of K—the resistance constant, and the pressure drop expressed as a difference of squares *(Fig. 4)*. Thus, the routine can be used through the pressure range of the flow formula. Reversal of flow from the original assumption is noted by a minus sign in the results. These results can be transferred to the working map by clerical personnel. Evaluation by the project engineer follows normal procedure.

CONCLUSION

It is felt that this routine and the use of the 704 computer has these several advantages over other methods:

1. **The performance** by the machine of two intermediate steps which have required manual calculation reduces the total time required to perform a network analysis.

2. **Simplification** of data requirements also reduces the amount of professional time required. It is estimated that this is about a 30 per cent reduction in engineering time and about 20 per cent in semi-professional or clerical time.

3. **Observation** and supervision of machine time by engineering personnel is eliminated.

4. **Cost** of the computing service for the completed analysis is comparatively low.

5. **The simplicity** and speed of the routine make practical studies which have not been done previously. Not only can annual studies and master plans be done more rapidly but it will be practical to examine budget proposals in detail and to study the effects of commercial and industrial loads before they are added.

While the Temco Program is a step forward, it does not represent the ultimate in network analysis calculations. Constant research and study are required to apply advanced technology to the solution of distribution problems. The determination and application of system loads for these problems may one day be done by the use of digital computers. The field is open. The challenge is there to be met. ■

PERIODIC METER CHANGING

SOUTHERN COUNTIES

EVOLUTION IN TRUCKS:

CURRENT "SPECIALS" WORK WELL BUT COMPACTS COMING

The second installment in a three-part series by Albert D. Petersen, customer service manager at Southern Counties Gas Co. Next month, the series concludes with a discussion of PMC economics and philosophy, emphasizing the importance of the fieldman's attitude and good scheduling.

PRIOR to the advent of the hot meter change device described in detail last month, Southern Counties Gas Co. regarded periodic meter changes primarily as fill-in work. PMC's were spread among all customer service fieldmen, to be handled on their regular routes. Of course, there was some specialization. Occasionally, a fieldman would be dispatched—with a pickup loaded with meters—for a day of PMC work. However, this was not the general rule and most changes were done on a piecemeal basis as fill-in work. Although this was not the most efficient way to do the job, it was the way it had been done for years, primarily because it served as a load balancer.

After World War II, two things happened. First, the hot meter change device had developed to the extent that it became the best way to change meters. Second, the number of periodic meter changes to be done each year had increased to the point where they could no longer be considered as fill-in work. This was especially true in our four larger operating divisions. Long before the company grew to its present 770,000-meter size, these two developments indicated that old-age meter change work was becoming more and more of a specialized operation and, as such, would require specialized truck equipment.

In designing specialized trucks for PMC work, it was agreed that there were two basic requirements: (1) sufficient meter carrying capacity, and (2) space for the auxiliary gas supply and the hot meter change device equipment. However, we did not want to make the design so specialized that the trucks could not be used for other types of work, such as meter setting,

This new multi-purpose truck sports company's new white with dark blue color scheme. Below, the hot change hose is inserted into the working position mounting bracket that also handles the vise stored below and to the left of the bracket. Note the hot change device tray and the cylinder for auxiliary gas supply behind it.

turn-ons, and service work. If we adopted too specialized equipment, budget limitations might have put us in the position of being short of trucks for regular work.

Therefore, it was decided that two types of trucks —both equipped for meter changing—would best meet our needs. One would be a multi-purpose truck that could be used for routine work as well as periodic meter changes. The other would be designed specifically for PMC's and would be capable of handling a maximum day's work without returning to the base for additional meters.

A continuing program to acquire the most useful automotive equipment for these two functions—and to adapt it in the best manner possible—has resulted in the company now having suitable vehicles in all eight operating divisions. Constant review of results obtained and research on new equipment keep producing improvements. Two of the most modern of Southern Counties' trucks are shown in the accompanying photos.

The multi-purpose truck we now list as standard is a standard ½-ton pickup. For easy access to the bed, the tailgate is removed and a step bumper and grab bar are installed at the rear. Two utility-type bins are mounted on the side rails of the truck for pipe fittings and other material.

A steel plate is fastened to the end of the bin on the curb side for mounting either the hose reel or a

This periodic meter changing truck is a little older, is painted the gray SoCounties formerly used. Below, the parts bins are shown open. Note the swivel mounting for the hot change hose reel, the mixture of tin and iron meters, the location of the two gas cylinders (fieldman is working on one). Truck holds 26 to 28 meters.

vise, as needed. The holder arrangement permits easy interchangeability of vise and reel. Either may be left in the "working" position while the truck is driven.

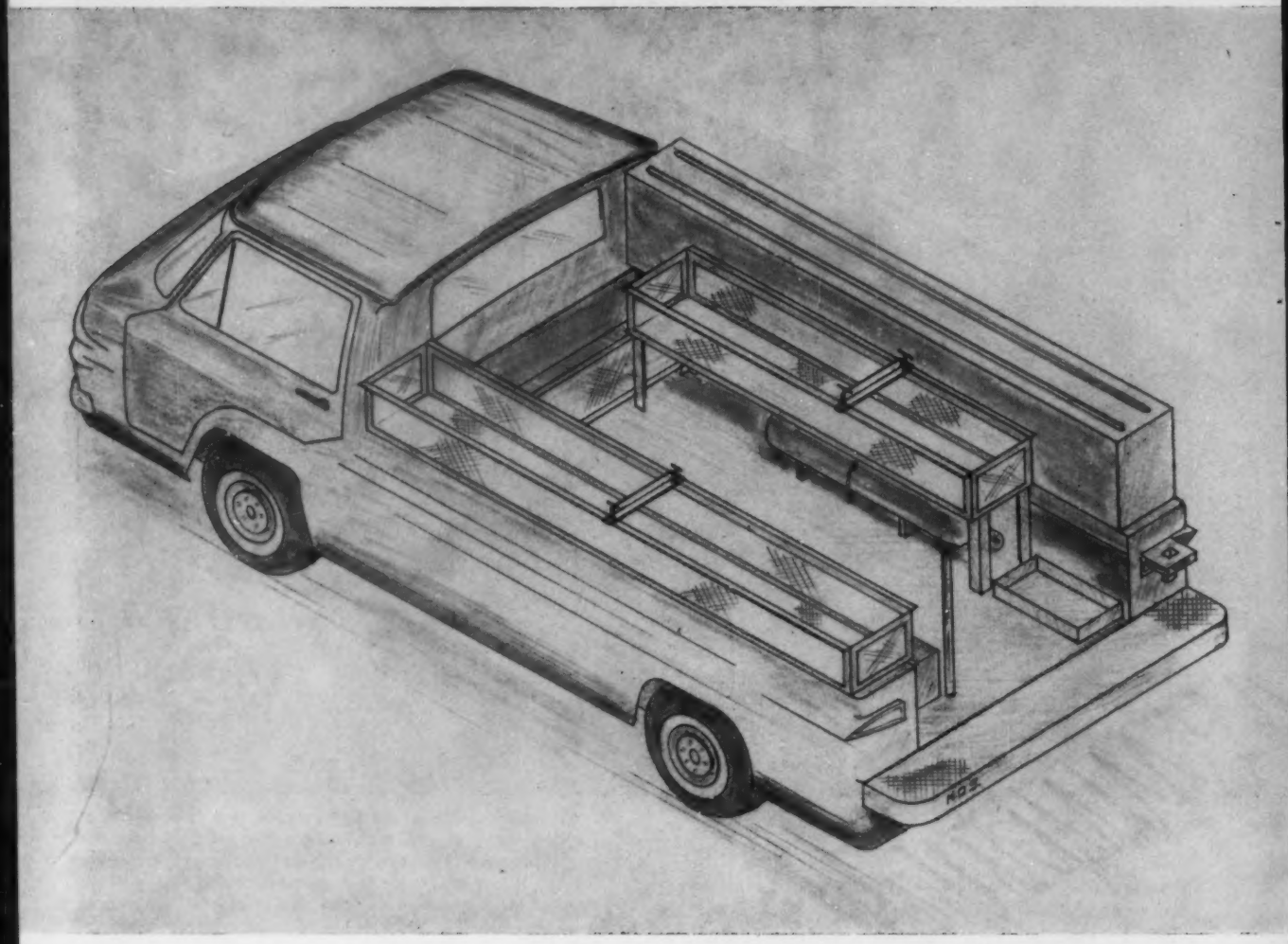
Two meter racks with angle-iron frame and expanded metal bottom are installed lengthwise, one on each side of the bed. The sides and ends of the racks are open and are designed to hold 5-, 10-, or 20-light meters, either all of one kind or mixed. Each rack holds six 5-lt. tin or seven iron case meters. They are held firmly in place by a sliding bar.

The meter rack on the curb side is elevated and the auxiliary gas supply cylinder for the hot meter change device is mounted under it.

The meter tray—containing the regulator and bag assembly for the change device, plus the meter setting tools—is held in place by an angle iron bracket on the bed at the right rear. Also mounted on the bed—at the left rear—is a turn-on tray holder, containing the tools for turning on appliances.

The specialized meter change truck we now consider standard equipment was built up on a ¾-ton chassis. The reason for not using a standard pickup was to keep the bed as low as possible for better visibility, balance, and easy access to the meters. A step-type bumper is added, and a grab bar is usually provided for safety in getting on and off the bed.

This truck also is equipped with two angle-iron frame meter racks, one on each side of the bed, but



they are longer than those on the multi-purpose truck. The sides and ends of these racks are covered with sheet metal, and the racks are raised to facilitate cleaning the bed. The two racks hold 17 5-lt. tin or 19 5-lt. iron case meters. Three open compartments below the bed, two on the street side and one on the curb side, carry an additional nine meters, making the total meter capacity 26 tin or 28 iron case 5-lt. meters.

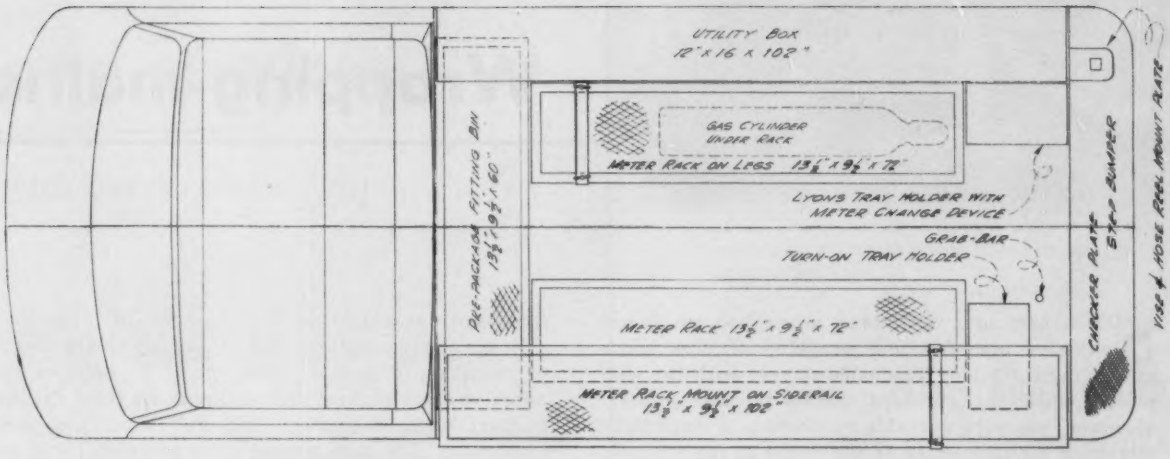
Regulators are stored in an open bin next to the street side meter rack.

Fittings and miscellaneous supplies are kept in two curb-side bins. One—with two drop doors—is on the bed alongside the meter rack. The other is below it, just behind the cab and in front of the rear wheel.

The auxiliary supply for the meter change equipment consists of two natural gas cylinders; the fieldman can use one fully without having to return to his base for another. Installed at the rear of the truck is the hose reel, mounted on a turntable so the hose can be unreeled from any position. The meter set tray—containing the regulator and bag assemblies of the meter change device—is mounted in an angle-iron bracket on the right rear of the bed. The turn-on tray is in a similar bracket on the left side.

Because this truck is designed particularly for changing meters, its use has been limited to those areas with sufficient PMC work to sustain its full-time operation. It has proved worthwhile in our four larger divisions, which each make from 8000 to 15,000 PMC's per year. These divisions, therefore, use both types of vehicles. In the four smaller divisions, each having only 2000 to 3000 changes a year, the multi-purpose truck has proved sufficient. At present Southern Counties has nine special PMC trucks and about 90 of the described multi-purpose trucks.

Other customer service trucks are equipped for limited meter changing. Southern Counties employs about 90 metermen, 230 servicemen and 28 service mechanics. Their equipment is not standard because of differences of population and terrain in service areas, and because trucks and truck bodies are replaced only as they wear out. In most cases, a meterman is equipped with a meter change truck or a multi-purpose truck. A serviceman generally drives a standard ½-ton chassis fitted with a utility-type body or a ½-ton pickup with a utility-type box. Either arrangement can be outfitted with three racks, each holding four meters. Generally a serviceman's truck is set up with one rack of four 5-lt. meters. A service



**Right and above,
picture and plan of what's to come,
the compact meter-change truck.
This drawing shows a Corvair
fitted with three meter racks
one long utility box,
and a pre-package parts bin.
Such a unit is expected to carry
twice the meters and at less cost.**

mechanic usually drives a truck with a utility-type body, but this is not an ideal situation because of a limited space for protecting materials and tools from the weather. Service mechanics rarely carry meters on their trucks unless a job specifically calls for it.

In 1950, Southern Counties had 155 trucks to perform all customer service work, including PMC's. Now, about 350 vehicles are required to do the job. On a large percentage of these vehicles, the servicemen's trucks, we are switching to utility-type boxes from utility-type bodies. While we still have over 170 bodies, which are being shifted from chassis to chassis as they grow older, we find boxes more suitable to our present operations.

Evolutionary change is inevitable. Although we have been well satisfied with the special meter change trucks and the multi-purpose meter trucks, we see some real possibilities in the new compacts. The large, low bed and high payload of the Chevrolet Corvair and Ford Econoline pickups seem to be made to order for this type of operation. In addition, their ease of driving and parking, lower initial cost, lower operating costs, lower maintenance costs, and less cost to outfit will be advantages.

Although we have not yet used compacts in meter changing work, we have developed tentative plans. The accompanying drawings show proposed plans for equipping a Corvair pickup as a multiple-purpose truck. One of the big advantages of the compact is its long bed, which doubles the meter-carrying capacity. The extra length also allows a single 102-in. utility box for fittings—in place of the two boxes used on our present trucks.

Incidentally, we have already experimented with a Corvan (enclosed model) for service mechanics. It seems ideal for keeping expensive tools—such as those used for testing air conditioning installations—out of the weather and under lock. We have more van-type compacts ordered, including one Econoline.

Just as numerous changes in meter changing trucks have been made in recent years, so it is certain that other changes will be made in the future. New equipment, materials, and techniques continually affect our operations. New cost studies give us more information about the things we must do to keep expenses down without cutting down on the service. New regulations and management goals expand or limit our scope of operations. We expect that 1970 will find our meter trucks way down the progress road from where they are now. ■

By J. R. GREY
B. C. Electric Co. Ltd., Vancouver, B.C.

Wrapping mains

SOME years ago, we made an attempt to use plastic adhesive tape for field wrapping of pipe joints and fittings. We had reasonable success with the simplest application (standard welded pipeline joints). However, we were not able to produce a watertight wrapping for such areas as are found at the junction of pressure control tees, fittings and unsymmetrical branch connections.

The problem evolved from the unconformability of tape and the lack of adhesive contact between plastic and steel when wrapping concave surfaces which are developed invariably at the junction of dissimilar cylindrical pipe sections and at sudden enlargements or reduction of section (caps, etc.). To improve the adhesive value at these difficult areas, we tried various primers under laboratory and well supervised field conditions. The tape proved quite successful but required deft application ability. When the worker did the job under field conditions, a very large percentage of the jobs were unsatisfactory, yielding the same failure as without primer. Subsequently, we abandoned the whole idea of tape wrapping as being impractical.

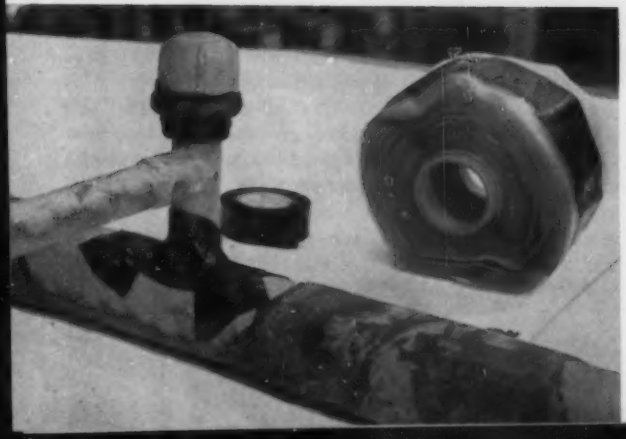
Three years later, after the advent of natural gas, many instances of corrosion began to appear throughout our newer pipe system at joints and at the site of weld attachments, etc. Interest was reborn for a superior joint wrapping material and method. Among the likely substitute materials was tape again, newly improved and guaranteed to stick better than ever. The tape material was now a very compliant film and appeared to be the answer to our former problem. Our tests revealed that adhesives also had improved. In combination with the superior tape, they appeared to be the answer to our needs. However, we found that tape alone could not consistently seal out water at the difficult locations under normal field conditions.

Analyzing the problem, we decided that if some commodity could be applied to build out the hollow surfaces, the tape adhesive would not be required to develop so great a bond and should produce the necessary adherent capsule to make a waterproof wrap.

We tried various products, most of which were either not practical or usable in their available form. What we needed was a material that was compliant, plastic but not elastic, inert to soil water attack, stable and compatible with steel, tape, and tape adhesives. Among the test materials was a butyl tape available in 2-in. width with all the physical features we sought. Tests indicated it to be extremely inert and chemically ideal for our purpose. This material is nearly pure butyl rubber, only slightly filled and practically unaffected by age.

We are using this butyl tape in conjunction with a 14 mil polyethylene tape including 4 mils of adhesive. By applying small strips of butyl tape to rough and concave surfaces and to voids produced at sudden change in pipe and fitting diameter (see photos), we

"By application of small strips of butyl tape applied to rough and concave surfaces and to voids produced at sudden changes in pipe and fitting diameter (above and below), we are able to prepare an almost ideal base for simple wrapping . . ."



and services

with butyl molding tape

are able to prepare an almost ideal base for simple wrapping with adhesive polyethylene tape. Butyl molding tape is extremely tacky and develops a good bond with steel in a few days. No primer is required with butyl tape.

Successful use of this new combination wrapping was not won without careful introduction to the work crews. We trained a pair of coating inspectors in its use and gradually trained all prospective users in the field. Inspection of the tape-wrapped joints is quite practical by use of an electrical holiday detector set at about 8000 v. The inspectors have been very effective in developing the interest of the work crew for doing a good job. They have been severe in their inspections, requiring unsatisfactory joints to be rewrapped.

We have had proven performance of this butyl-polyethylene wrapping in cathodically protected areas of gas mains and services. A particular area of system piping which had been wrapped with the new coating materials was isolated and protected with cathodic potentials. An adjoining area of approximately the same pipe exposure and soil conditions was also placed under cathodic protection; however, in this area all field wrapping had been done with glass cloth and cut-back bituminous cement. We knew the workmanship of field wrapping on this latter section was not up to our present standard but the basic coal tar coating on the pipe was the same in both areas.

Initial cathodic protection current on the tape-wrapped area was considerably lower than the bituminous cement wrapped area, attesting the direct benefit of the new coating. Over a year later cathodic current consumption in the tape-wrapped area had not changed but in the other area current consumption had doubled, requiring the addition of many more galvanic anodes.

* * *

The benefits of good field coating have been revealed in other areas where there is a preponderance of mains wrapped with the combination of butyl and polyethylene tape. We expect that by doing a first class job of field wrapping to complement the carefully mill-wrapped pipe, new mains will last longer. Where it is found desirable to back up coatings with cathodic protection, the reduced current requirement will make this useful agent infinitely practical. ■

AGA Lab inspector Anthony Casasanta, looks over one of the lab's new utility-type station wagons.

AGA Labs using mobile inspection units

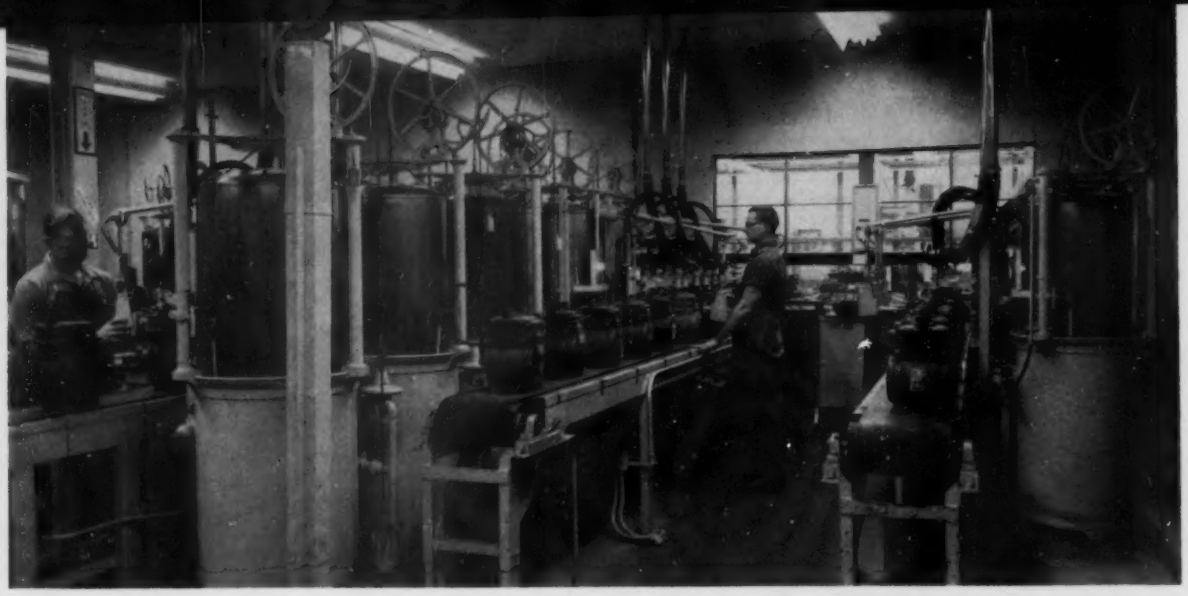
"MEET me outside of your office in 30 minutes. I have something I want you to see," is what Frank Hodgden, director of the American Gas Association's laboratories, told this GAS Magazine editor in Cleveland the day before the Research and Utilization Conference opened. Twenty-eight minutes later, he wheeled up to the appointed place driving a gleaming white Chevrolet Greenbrier utility-type station wagon.

"This," he proudly proclaimed, "is one of our two new mobile field inspection service units. We're going to use one of them here at the Cleveland laboratories and the other at the Los Angeles labs."

Promptly dubbed "Moby Dick" by GAS Magazine, the vehicles will be equipped with instruments to make temperature, pressure, and gas flow measurements. In addition, standard samples of carbon monoxide and carbon dioxide will be carried aboard. This equipment will be made available to appliance manufacturers during routine plant visits by laboratory inspectors so that the manufacturers will be able to accurately calibrate their testing devices.

Another contemplated use of the mobile units will be for in-plant testing at the time of factory inspection. It is also anticipated that at least some test work can be conducted at the manufacturer's plant where this saving in time would justify the expense of field work.

The laboratory's Seal of Approval is prominently displayed on both sides of the Greenbrier. Hodgden said he hopes eventually to make the vehicle a true representative of the gas industry by converting its carburetion system to propane. ■



Meter maintenance

ONE of the major concerns of utilities is to streamline operating and maintenance operations in order to counteract higher wages, rising fuel prices, and other cost increases beyond management's control.

In the area of gas meter maintenance, the trend has been towards cost savings through consolidation of maintenance operations in one central location rather than doing repair work in a number of different smaller shops throughout the system.

Consolidation of meter maintenance operations was achieved by Consumers Power Co. in 1954 with the completion of the general meter building on a 71-acre tract north of the city limits of Jackson, Mich., site of the company's new headquarters.

Consumers Power Co. provides both electric and gas service in 64 Michigan counties. Until 1954, the company's gas and electric meters were processed in 16 different locations throughout the area. By consolidating both the electric and gas meter maintenance in the new building, major economies have been achieved in the transport and handling of the meters. About 175,000 electric and 105,000 gas meters are processed annually in the new building.

The former 16 repair centers are now being used as pick-up points, field testing centers and operating quarters of the field staff responsible for the installation and removal of meters.

Each of the field centers is visited once a week for pick-ups and deliveries. Our transportation equipment consists of two tractors and three semi-trailers. The trailers are standardized to hold 24 "Cargotainers" each. Each Cargotainer holds 48 standard 175-cu ft gas meters or 88 electric meters.

In addition to cost savings achieved through consolidated transport and handling of gas and electric meters, major efficiencies and savings have been achieved in the processing of the gas meters by: (1) use of electronic provers; (2) maintenance of IBM card records for every one of our outstanding meters; and (3) standardization on synthetic diaphragms for all replacements as well as in new meters.

The total number of outstanding gas meters at present is about 555,000. About 10,000 of these are commercial and industrial meters. Some 130,000 of our meters are the older types of tin meters used only on standard pressures of 6-in. wc in downtown areas. Hard case meters are used on intermediate pressures up to 40 psi. The standard domestic gas meter size is 175 cu ft.

New domestic meters are being installed at the rate of about 34,000 annually. In addition, 6000 older meters are retired annually, making a total of about 40,000 new meters per year.

All meters are inspected at regular intervals. Maintenance cycles for positive displacement meters are as follows: domestic meters, 10 years; space heating meters, seven years; commercial meters, seven years; industrial meters, five years or 15 MMcf, whichever comes first.

Domestic meter line of Consumers central meter maintenance shop (far left). One man operates six electronic provers simultaneously for in-testing. This page: Low pilot test uses air at 4 in. w.c. pressure through a No. 78 drill hole, with a time limit of one cycle of tangent.

efficiency

By R. C. TURNER,
General Gas Meter Supervisor
Consumers Power Co., Jackson, Mich.

Meters received from the field for processing are first sorted according to make and size. They are then placed in an air-conditioned proving room for 24 hours to adapt to the test room temperature.

Meter sizes up to 300 cu ft per hour are handled by the automatic conveyor line which passes all maintenance stations throughout the shop. Larger capacity meters are handled individually.

Fifteen electronic provers of 5-cu ft capacity are used, plus three 10-cu ft provers with automatic filling and zeroing. On the domestic meter line, one man operates six provers simultaneously for in-testing.

The in-testing data are recorded by an operator with a regular adding machine on adding machine tape. This has the advantage of speed and legibility. Data recorded on the tape (but not added up, of course) include the meter number, the open and check test reading, and the differential reading. The tape is sent to our meter records office, where data are transferred to an IBM card, which is maintained for every meter.

A gas meter test and repair card is prepared at time of outproving the meter. Information as to final calibration and class of repair appears on this card and is used in analyzing production, quality control and meter performance.

The IBM system makes it possible, at any time, to pull out vital information and the history of any meter. It also permits the efficient compilation of useful statistics required on a meter maintenance program.

During in-testing the meters are classified in three categories:

A meters (Okay meters)—reading between 0 to 2 per cent slow, with a differential not exceeding 0.3 in. wc at 60 cu ft per hour.

B meters (to be adjusted)—reading between 2 and 3 per cent slow or between 0 and 2 per cent fast, and with a differential not exceeding 0.35 in. wc at 60 cu ft per hour.

C meters—all those exceeding limits of A and B meters, and requiring full repair procedures.

A Dwyer slope gauge is used for differential testing. Standards established for the gauge are a factor in determining the type of repair required for a meter. For example, a 175-cu ft meter with a draft above 0.30-in. wc and with more than 0.10-in. wc fluctuation will be classified C, requiring removal of top and full repair processing.

In subsequent repair stages, C meters are further separated into meters requiring new diaphragms and major repairs. The classification for meters with leather diaphragms requiring re-oiling has been practically eliminated, since dried-out leather diaphragms are replaced with synthetics.

All tin meters not passing the A, B, or C classification are automatically retired, as well as all tin meters more than 35 years old. These meters are in-tested

before retirement, and their records are kept on file to satisfy state regulations.

Currently, repair records show the following percentages of different categories of meters repaired: A meters, 11.2 per cent; B meters, 50 per cent; C meters and others, 38.8 per cent. About 10.5 per cent of the C meters require diaphragm replacement.

After steam cleaning, and sand blasting where required, all A meters undergo a leak test and a low pilot test. Air is employed for the pilot test—through a No. 78 drill hole using air at 4 in. wc pressure, with a time limit of one cycle of tangent. Test data are entered on the gas meter test and repair card. After completion of the test, the meters are painted in the spray booth.

B meters are adjusted to within the limits of 0 to 2 per cent slow and 0.3 in. wc of differential. Otherwise they undergo the same treatment as A meters.

C meters are subjected to all repair steps—top is removed, diaphragm inspected, inside cleaned, worn parts replaced, valves ground, and stuffing box repacked. The meters are then tested for leaks, low piloted, proved, and repainted.

Whenever diaphragms must be replaced, synthetics are used. The Vulcan 95X's are standard for all replacements, and normally are specified for new meters. Practically all diaphragms that require replacement are leather. None of the synthetic diaphragms installed during the past six years, except a few that were mechanically damaged, have required replacement so far. As the number of synthetic diaphragms in our system increases, it is expected that the diaphragm replacement rate will decrease.

About 400,000 meters with leather diaphragms are still in service. Most of these date back to a changeover from manufactured gas to natural gas which was completed in 1943. All diaphragms used before the changeover were replaced by new leather diaphragms within the next three years because of the drying effect of natural gas.

In 1954 experimentation was begun with synthetics. Samples were installed in different types of meters throughout the system. Based on these test results, and following reports of other utilities on their experience with synthetics, synthetics became standard in June 1956.

At present diaphragms are replaced in about 6000 meters per year. In addition 6000 meters with leather diaphragms are retired per year, thus reducing the number of outstanding meters with leather diaphragms by about 12,000 per year. However, as the leather diaphragms are increasing in age, an acceleration of this replacement rate is expected in the future.

Large meters, handled individually, are processed under the same classification system and repair procedures as domestic meters. Service regulators up to 2 in. are also repaired in the general meter building. About 370,000 regulators are in service. About 7000 per year are rebuilt annually and about 34,000 new regulators are added to the system. When standard pressures were raised in the system a change was made from no-seal regulators to mechanical seal regulators.

To sum up the economies: Even though the number of meters in the system has increased from 393,000 in 1954, when centralized meter maintenance operations began, to 555,000 today, the total number of gas meter maintenance operators (39) has remained the same. The increased output per manhours is largely due to the use of electronic provers and the conveyor system. Diaphragm maintenance time has been reduced by eliminating the oiling of leather diaphragms and by increasing the number of synthetic diaphragms in service. The use of adding machines and IBM cards has improved record keeping. Records can be maintained and checked faster, and valuable statistics compiled that permit the most efficient planning of meter maintenance operations. ■

Above: Repair data for every meter are maintained on IBM cards at Consumers' central meter maintenance shop. Right: Diaphragm in a larger meter is replaced by a synthetic.

A REFRESHER COURSE IN GAS PRODUCTION, TRANSMISSION, DISTRIBUTION, AND UTILIZATION

By Irving Deutsch

PART 2: What is gas?

IN the introductory article, a brief history of the gas industry was given and some major components of manufactured gas were mentioned. In this article, some important properties of gas will be introduced to the extent of applying the information to understanding gas as a fuel. No effort will be made to give a course in chemistry or physics.

Gas, in the physical sense, is one of three states of matter and similar to a liquid in that it will not hold a shape. Unlike a liquid, its component molecular particles have been excited, by the addition of energy, to the extent that they collide with one another, and the container they are in, in the same way that ping-pong balls collide in a container that is agitated by air. The ping-pong balls need the constant stirring of the air to stay in motion. But molecules of gas collide in a purely elastic manner; that is, without loss of energy. Hence, gas molecules will go bouncing around indefinitely, which brings us to the first easily observable property of gas—namely, *pressure.*

When a mass changes velocity, some force must act upon it to cause said change in velocity, called acceleration or deceleration. The force on the surface of a container, for example, due to the many millions of molecules hitting the contain walls and reversing direction (i.e., a great change in velocity) when expressed as pounds per square inch, is called pressure. For all practical purposes this is a uniform force as witnessed by the fact that a ball or plate hanging in midair does not move.

This idea of particles and velocity might bring one to think of the ability of different molecules of different weight, or mass, to flow through a hole in the wall of its container; or for that matter, to flow through a pipe which may be thought of as a hole in a container with very thick walls. One thing that seems sure is that the smaller molecules will be able to get through smaller holes, and the greater velocity of a particle will permit it to bounce off sides of a container more times in any unit of time; hence, it has more chances to hit the hole so it can get through.

A less obvious fact was observed by Avogadro, who carefully observed combining weights of gas compounds. He concluded that equal volumes of gas at the same pressure and temperature had the same number of molecules. Hence, 44 lb of propane (C_3H_8) will have the same number of molecules as 28.8 lb of air when all conditions are the same. This tells us that the velocity of the lighter molecules must be greater than the velocity of the heavier molecules. Therefore, we can expect that it will be easier for a light gas to move through a hole or pipe.

As far back as 1829, Graham noted that rates of diffusion of various gases were inversely proportional to the square root of their density or molecular weight. The kinetic theory of gases, proposed by Bernoulli in 1738, shows by a consideration of the rate of change of momentum, mass x velocity (when a molecule hits a surface, and the distance it must travel in a container) that the velocity is inversely proportional to the density of the gas. Therefore, the relative velocity that gases of different molecular weight will travel through a pipe is $1/\sqrt{d}$. *Don't forget this.*

From Avogadro's Law it becomes a simple matter to determine the relative heaviness of gases by taking the ratio of their molecular weights. If the gas is compared to air, it is called the specific gravity. So, propane with a molecular weight, M, of 44, has a specific gravity, SG, of 44/28.8 or 1.52 theoretically. The velocity of the gas varies proportional to the $\sqrt{SG}$. Don't forget this either, for it is a basic concept that will be used in the following articles.

Our primary goal is the consideration of gaseous fuels. Our only reason for using gas is the heat energy that is released when gas is burned with oxygen or air. The unit of heat measurement is the British thermal unit, or Btu. It is defined as the heat required to raise the temperature of 1 lb of water (at 60 deg F) 1 deg F. For practical purposes the unit of volume used is the cubic foot; hence, the unit of heating value for gas is Btu per cu ft of gas at 60 deg F and 30 in. of mercury pressure.

The heat-carrying capacity of a given gas through a gas main may be evaluated in terms of a simple ratio of heating value, H, divided by the $\sqrt{SG}$—all

Table 1. Gas Combustion constants

No.	Gas	Formula	lb cu ft	cu ft lb	Sp. Gr. Air = 1.000	Heat of Combustion: Btu per cu ft: Gross	Heat of Combustion: Btu per cu ft: Net	Heat of Combustion: Btu per lb: Gross	Heat of Combustion: Btu per lb: Net	Cu ft per cu ft of Combustible: Required for Combustion: O₂	Required for Combustion: N₂	Required for Combustion: Air	Flue Products: CO₂	Flue Products: H₂O	Flue Products: N₂	Lb per lb of Combustible: Required for Combustion: O₂	Required for Combustion: N₂	Required for Combustion: Air	Flue Products: CO₂	Flue Products: H₂O	Flue Products: N₂
	Carbon	C				323.5	275.1	14,140	14,140	0.5	1.882	2.382	....	1.0	1.882	2.667	8.873	11.540	3.667	8.939	8.873
2	Hydrogen	H_2	0.005327	187.723	0.06950			61,100	51,643							7.939	26.414	34.353			26.414
3	Oxygen	O_2	0.08461	11.819	1.1056																
4	Nitrogen (atmos.)	N_2	0.07439	13.443	0.9718																
5	Carbon monoxide	CO	0.07404	13.506	0.9672	323.5	323.5	4,369	4,369	0.5	1.882	2.382	1.0	....	1.882	0.571	1.900	2.471	1.571	....	1.900
6	Carbon dioxide	CO_2	0.1170	8.438	1.5282																
Paraffin series CnH_{n+2}																					
7	Methane	CH_4	0.04243	23.565	0.5543	1014.7	913.8	23,912	21,533	2.0	7.528	9.528	1.0	2.0	7.528	3.992	13.282	17.274	2.745	2.248	13.282
8	Ethane	C_2H_6	0.08029	12.455	1.04882	1781	1631	22,215	20,312	3.5	13.175	16.675	2.0	3.0	13.175	3.728	12.404	16.132	2.929	1.799	12.404
9	Propane	C_3H_8	0.1196	8.365	1.5617	2572	2371	21,564	19,834	5.0	18.821	23.821	3.0	4.0	18.821	3.631	12.081	15.712	2.996	1.635	12.081
10	Iso-butane	C_4H_{10}	0.1582	6.321	2.06654	3251	2999	21,247	19,606	6.5	24.467	30.967	4.0	5.0	24.467	3.581	11.914	15.495	3.030	1.551	11.914
11	n-butane	C_4H_{10}	0.1582	6.321	2.06654	3353	3102	21,247	19,606	6.5	24.467	30.967	4.0	5.0	24.467	3.581	11.914	15.495	3.030	1.551	11.914
12	n-pentane	C_5H_{12}	0.1904	5.252	2.4872	3901	3579	20,508	18,922	8.0	30.114	38.114	5.0	6.0	30.114	3.581	11.914	15.495	3.067	1.488	11.745
13	n-hexane	C_6H_{14}	0.2274	4.398	2.9704	4687	4315	20,626	18,976	9.5	35.760	45.260	6.0	7.0	35.760	3.530	11.745	15.275	3.067	1.466	11.745
Olefin series CnH_n																					
14	Ethylene	C_2H_4	0.07496	13.412	0.9704	1613.8	1530	21,884	20,525	3.0	11.293	14.293	2.0	2.0	11.293	3.425	11.395	14.820	3.139	1.285	11.395
15	Propylene	C_3H_6	0.1110	9.007	1.4504	2336	2185	21,042	19,683	4.5	16.939	21.439	3.0	3.0	16.939	3.425	11.395	14.820	3.139	1.285	11.395
16	Butylene	C_4H_8	0.1480	6.756	1.9336	3135	2884	20,840	19,481	6.0	22.585	28.585	4.0	4.0	22.585	3.425	11.395	14.820	3.139	1.285	11.395
17	Acetylene	C_2H_2	0.06971	14.344	0.9107	1503	1453	21,572	20,840	2.5	9.411	11.911	2.0	1.0	9.411	3.075	10.231	13.306	3.383	0.692	10.231
Aromatic series CnH_{n-6}																					
18	Benzene	C_6H_6	0.2060	4.852	2.6920	3741	3590	18,160	17,418	7.5	28.232	35.732	6.0	3.0	28.232	3.075	10.231	13.306	3.383	0.692	10.231
19	Toluene	C_7H_8	0.2431	4.113	3.1760	4485	4296	18,456	17,701	9.0	33.876	42.876	7.0	4.0	33.876	3.128	10.407	13.535	3.346	0.783	10.407
20	Xylene	C_8H_{10}	.....	.....	.....	5155	.....	18,410	.....	10.5	39.524	50.024	8.0	5.0	39.524	3.168	10.540	13.708	3.318	0.849	10.540
21	Naphthalene	$C_{10}H_8$	.....	.....	.....	5859	.....	17,298	.....	12.0	45.170	57.170	10.0	4.0	45.170	2.999	9.978	12.977	3.436	0.563	9.978
Miscellaneous gases																					
22	Ammonia	NH_3	0.03482	21.914	0.5961	433	.....	9,586	.....	....	.....	.....	....	....	.....	.....	.....	.....	....	.....	.....
23	Hydrogen sulfide	H_2S	0.09109	10.979	1.1886	672	.....	7,479	.....	1.5	5.646	7.146	SO_2 1.0	1.0	5.646	1.408	4.685	6.093	SO_2 1.880	0.529	4.685
24	Sulfur dioxide	SO_2	0.1722	5.770	2.264	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
25	Water vapor	H_2O	0.04758	21.017	0.6215	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
26	Air	.....	0.07685	13.063	1.0000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

other conditions being the same, such as pipe diameter, pressure difference, internal wall conditions, temperature, etc. The $H/\sqrt{SG}$ value of a gaseous fuel is a very important basic unit that should be as familiar to you as temperature, weight and pressure.

If carbon monoxide is burned, the only product produced—assuming complete combustion—is carbon dioxide, a non-condensable vapor at normal temperature and pressure. And the total product will remain as a vapor. If methane (CH_4) is burned, water is produced and will condense if the combustion products are brought back to the initial temperature conditions. Then, heat required to vaporize the water will be released. Since actual heating value, or total heating value, can be determined only if combustion products are brought back to the initial temperature of the fuel and air, the latent heat of vaporization of the water must be added to the heating value obtained if the combustion products were not permitted to condense. The net heating value is the heating value obtained without condensation. The gross heating value is the value obtained with condensation of the water produced. Expressed as an equation:

Net HV plus Latent Heat of Vaporization = Gross HV. As an example, take the combustion of methane:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2\,H_2O + 1016 \text{ Btu/cu ft of methane}$$

The equation as written actually represents a pound-mole of methane. That is, it represents the molecular weight in pounds. For methane: carbon has an MW of 12 and hydrogen an MW of 1.

Therefore $12 + 4 = 16$

By the application of Avogadro's law it can be established that a pound-mole, or mole-pound if you wish, of an ideal gas at 60 deg F and 30 in. mercury pressure will have a volume of 379 cu ft; hence, 16 lb of methane will occupy 379 cu ft. Since 2 moles of water are produced at 18 lb per mole (16 + 2), there is a total of 36 lb of water produced by the combustion of 16 lb of methane.

The heating value is expressed in Btu per cu ft; hence, the pounds of water produced per cu ft of methane is:

$$\text{lb } H_2O/\text{cu ft methane} = 36.379 \approx .1$$

Since the latent heat of evaporation of water is 1057 Btu per pound, the heat released by condensation of the one-tenth pound produced is approximately 100 Btu. The net HV becomes:

$$\text{Net HV } CH_4 = 1016 - 100 = 916 \text{ Btu/cu ft}$$

At this point it is necessary to bring in the difference between net vs. gross HV and wet vs. dry HV, since the two are often confused. A liquid that partly fills a closed container will vaporize until an equilibrium is set up between the liquid and the vapor therein. At normal temperatures and pressures, gases and vapors tend to act as if they were the only particles occupying the space. The total pressure of a gas mixture is the sum of the pressures of each of the gases and vapors occupying the space. Water vapor has a vapor pressure, at normal atmospheric pressures and temperatures, that is 1.7 per cent of

Table 2. Physical constants of hydrocarbons and other compounds associated with natural gas.

(Courtesy California Natural Gasoline Association)

	Methane	Ethane	Propane	Iso-Butane	N-Butane	Iso-Pentane	N-Pentane	N-Hexane	N-Heptane	N-Octane	N-Nonane	N-Decane	Carbon Monoxide	Carbon Dioxide	Nitrogen	Oxygen	Air	Hydrogen Sulfide	Water
MOLECULAR FORMULA	C_1H_4	C_2H_6	C_3H_8	C_4H_{10}	C_4H_{10}	C_5H_{12}	C_5H_{12}	C_6H_{14}	C_7H_{16}	C_8H_{18}	C_9H_{20}	$C_{10}H_{22}$	CO	CO_2	N_2	O_2	.....	H_2S	H_2O
MOLECULAR WEIGHT	16.042	30.068	44.094	58.120	58.120	72.146	72.146	86.172	100.198	114.224	128.250	142.276	28.010	44.010	28.016	32.000	28.966	34.076	18.016
MELTING POINT—(760 m. m. Hg. Press.)																			
°F.	−296.5	−297.9	−305.8	−255.3	−217.0	−255.8	−201.5	−139.6	−131.1	−70.2	−64.4	−21.5	−337.0	.....	−345.6	−361.1	.....	−121.9	+32.0
°C.	−182.5	−183.3	−187.7	−159.5	−138.3	−159.9	−129.7	−95.3	−90.6	−56.8	−53.6	−29.7	−205.0	.....	−209.8	−218.4	.....	−85.5	0.0
BOILING POINT—(760 m. m. Hg. Press.)																			
°F.	−258.7	−127.5	−43.7	+10.9	+31.1	+82.1	+96.9	155.7	209.2	258.2	303.4	345.2	−312.7	−109.3	−320.4	−297.4	−317.7	−76.5	+212.0
°C.	−161.5	−88.6	−42.1	−11.7	−0.5	+27.9	+36.1	68.7	98.4	125.7	150.8	174.0	−191.5	−78.5	−195.8	−183.0	−194.3	−60.3	+100.0
CRITICAL TEMPERATURE																			
°F.	−116.5	+90.1	206.3	275.0	305.6	370.0	385.9	454.5	512.6	565.2	613.0	655.0	−218.2	+88.	−232.8	−181.8	−221.3	+212.7	+705.4
°C.	−82.5	+32.3	96.8	135.0	152.0	187.8	196.6	234.7	267.0	296.2	322.8	346.1	−139.0	+31.1	−147.1	−118.8	−140.7	+100.4	+374.1
CRITICAL PRESSURE																			
Atmospheres	45.8	48.2	42.0	36.0	37.5	32.9	33.3	29.9	27.0	24.6	23.5	21.8	35.0	73.0	33.5	49.7	37.2	88.9	218.2
P. S. I. Abs.	673	708	617	529	551	483	490	440	397	362	345	320	514	1,073	492	730	547	1,306	3,206
CRITICAL DENSITY—(Lbs./Gal.)	1.351	1.695	1.888	1.946	1.891	1.955	1.935	1.958	1.957	1.942	1.935	1.919	.....	3.839	2.596	3.589	2.588	.....	2.658
CRITICAL VOLUME—(Cu. Ft./ Lb. Mol.)	1.593	2.366	3.219	4.214	4.092	4.942	4.978	5.903	6.834	7.790	8.631	9.547	.....	1.532	1.443	1.192	1.496	.....	0.906
DENSITY OF LIQUID																			
Specific Gravity—(60/60)	0.3	0.374	0.5077s	0.5631s	0.5844s	0.6248	0.6312	0.6640	0.6882	0.7068	0.7217	0.7341	0.801ℓ	(1.56 Solid)	0.808ℓ	1.140ℓ	0.856ℓ	0.790ℓ	1.000
°A. P. I.	340	247	147.2	119.8	110.6	95.0	92.7	81.6	74.1	68.7	64.6	61.3	.....	.....	.....	.....	.....	47.6	10.0
Lbs./Gal.—(60°F.)	2.5	3.11	4.224	4.685	4.863	5.200	5.253	5.527	5.728	5.883	6.008	6.114	.....	.....	.....	.....	.....	6.58	8.328
Gals./Lb. Mol. (60°F.)	6.4	9.67	10.44	12.40	11.95	13.88	13.74	15.59	17.49	19.41	21.35	23.27	.....	.....	.....	.....	.....	5.18	2.16
DENSITY OF VAPOR—(760 m. m. Hg. 60°F. Perf. Gas.)																			
Specific Gravity—(Air = 1.000)	0.554	1.038	1.522	2.006	2.006	2.491	2.491	2.975	3.459	3.943	4.428	4.912	0.967	1.519	0.967	1.105	1.000	1.176	0.622
Lbs./m Cu. Ft.**	42.27	79.23	116.19	153.15	153.15	190.11	190.11	227.07	264.03	300.99	337.95	374.91	73.81	116.0	73.82	84.32	76.33	89.79	47.47
Cu. Ft. Vapor/Gal. Liq.*	59	39.25	36.35	30.59	31.75	27.40	27.68	24.38	21.73	19.58	17.80	16.32	.....	.....	.....	.....	.....	73.28	175.44
Ratio Vapor Vol./Liq. Vol.	442	293.6	271.9	228.8	237.5	205.0	207.1	182.4	162.6	146.5	133.2	122.1	.....	.....	.....	.....	.....	548.2	1,312.4
BOYLE'S LAW DEVIATION FACTOR (760 mm Hg.)																			
50°F.	1.0020	1.008	1.016	1.030	1.032	1.045	1.048	1.066	1.087	1.100	1.120	1.140	1.0004	1.0058	1.0003	1.00075	1.00039	1.0110	1.0095
100°F.	1.0015	1.007	1.013	1.025	1.027	1.040	1.043	1.056	1.071	.....	.....	.....	.....	1.0047	1.00012	1.00052	1.00020	.....	.....
GROSS HEAT OF COMBUSTION																			
B. T. U./Lb. Vapor	23,891	22,329	21,670	21,265	21,315	21,046	21,094	20,949	20,842	20,764	20,701	20,653	4,350	.....	.....	.....	.....	7,480	.....
B. T. U./Cu. Ft.—(760 mm Hg.**, 60°F. Dry***)	1,010	1,769	2,518	3,256	3,264	4,001	4,009	4,756	5,503	6,250	6,996	7,743	321	.....	.....	.....	.....	680	.....
B. T. U./Gal. Liq. (60°F.)	.....	69,000	91,044	99,097	103,047	108,820	110,125	115,069	118,658	121,420	123,625	126,456	.....	.....	.....	.....	.....	.....	.....
EXPLOSIVE LIMITS—(% Gas in Air)																			
Lower	5.0	3.22	2.37	1.80	1.86	1.32	1.40	1.25	1.0	0.84	0.74	0.67	12.5	.....	.....	.....	.....	4.3	.....
Upper	15.0	12.45	9.50	8.44	8.41	.....	7.80	6.90	6.0	3.2	2.9	2.6	74.2	.....	.....	.....	.....	45.5	.....
CU. FT. AIR TO BURN 1 cu. ft. Gas	9.53	16.67	23.82	30.97	30.97	38.11	38.11	45.26	52.41	59.55	66.70	73.85	2.38	.....	.....	.....	.....	7.15	.....
HEAT OF FUSION—(Btu/Lb. @ 760 mm Hg.)	25.2	40.9	34.4	33.6	34.5	30.7	50.1	65.0	60.3	77.7	74.0	87.0	14.4	81.5	11.0	5.9	.....	30	143
HEAT OF VAPORIZ. AT B. P. @ 760 mm (Btu./Lb.)	219.7	210.7	183.5	157.8	165.9	146.9	153.8	144.2	136.2	131.9	126.9	120.2	91	.....	86	92	92	236	970
SPECIFIC HEAT (Btu/Lb. @ 760 mm Hg. and 60°F.)																			
Cp. Vapor	0.5271	0.4097	0.3885	0.3872	0.3970	0.3880	0.3972	0.3984	0.3992	0.3998	0.4003	0.4006	0.2484	0.1991	0.2482	0.2188	0.241	0.254	0.4446
Cv. Vapor	0.402	0.343	0.342	0.352	0.363	0.361	0.370	0.375	0.379	0.382	0.385	0.387	0.177	0.153	0.177	0.156	0.171	0.192	0.333
N = Cp/Cv	1.308	1.193	1.133	1.097	1.094	1.076	1.074	1.062	1.052	1.046	1.040	1.034	1.404	1.304	1.404	1.401	1.410	1.320	1.335
Cp Liquid	.....	.....	.534@ − 43°F.	.537@ + 14°F.	.548@ 0°F.	0.533	0.536	0.552	0.528	0.523	0.522	0.520	.....	.....	.....	.....	.....	.....	1.000
VAPOR PRESSURE at 100°F. (P. S. I. Abs.)	.....	780.e	190.	72.2	51.6	20.4	15.6	4.96	1.62	0.54	0.18	0.07	.....	.....	.....	.....	.....	554.6	0.949
ANILINE POINT—°F.	.....	.....	.....	225.7	181.2	168.3	159.3	155.5	159.1	161.1	166.8	171.5	.....	.....	.....	.....	.....	.....	.....
REFRACTIVE INDEX N_D^{20}	.....	.....	.....	.....	.....	1.3537	1.3575	1.3747	1.3876	1.3974	1.4054	1.4120	.....	.....	.....	.....	.....	.....	1.3330
OCTANE No. (Motor Method)	110	104	100	99	92	90.3	61.9	26.0	0	−17	−20	.....	.....	.....	.....	.....	.....	.....	.....
(Research Method)	+6g	+6g	+5.3g	+0.2g	88g	92.3	61.7	24.8	0	.....	.....	−53	.....	.....	.....	.....	.....	.....	.....

*—To convert to a Basis of 14.73 P.S.I. Multiply by 0.99769.
**—To convert to a Basis of 14.73 P.S.I. Multiply by 1.00232.
***—To convert to a Basis of Water Saturation @ 60°F. Multiply by 0.9825.

ℓ—Liquid Density at Boiling Point.
Methane and Ethane are "Apparent" Sp. Gr. of Liq. @ 60°F.—See Par. 13, App. 1.

s—At Saturation Pressure.
e—Ethane Vapor Pressure is Extrapolated Value.
g—Equivalent Octane Number (Gas).

the total normal atmospheric pressure. Or, if you wish to look at it another way, it has an equivalent volume of 1.7 per cent of the total volume it occupies (another application of Avogadro's Law). Now you can see that dry gas will have 1.7 per cent more gas than a gas that is wet if the equal volumes are at the same pressure and temperature. In this case, the term wet means saturated with water; hence, if at equilibrium, there is the slightest amount of liquid water, the space may be considered to be saturated or wet. The dry gas will have a heating value 1.7 per cent greater than wet gas; or turned around, the wet gas heating value will be 98.3 per cent of the dry gas.

As an example, if a natural gas has a heating value of 1017 Btu per cu ft on a dry basis, it will have a heating value of 1000 Btu on a wet basis. Most devices used to measure heating value first saturate the gas with water by passing it through a wet meter. To get the dry heating value it is only necessary to multiply the wet value by 1.017. It might be a good idea to mention the fact that to get accurate heating value test results, the exit gas temperature should be the same as the inlet gas temperature. Usually, this is not the case, but a correction can be made by taking into account the difference in temperatures and calculating the correction with a known value of specific heat; that is, the number of Btu required to raise the temperature 1 deg F.

The idea of vapor pressure of liquids applies to oils as well as water, and to all other liquids. Hence, if gas is saturated with a hydrocarbon vapor, such as gasoline, the heating value will be increased. Actually, even solids have a vapor pressure but it is so small that it usually can be neglected.

From the kinetic theory of gases and Avogadro's Law, it can be observed and derived mathematically that the product of the pressure and volume of a gas and mixtures of gases is directly proportional to the absolute temperature. As an equation:

$PV = k\,T$ where k is a constant of proportion rewritten:

$$\frac{PV}{T} = k$$

This says in effect that a closed container of gas at a pressure P_1, volume (fixed by the size of the container and varied by a piston or diaphragm) V_1, and absolute temperature T_1, will be related to the same gas at conditions P_2, V_2 and T_2 by the equation:

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

This equation is the combination of Boyle's and Charles' laws. This relation should be known as well as you know your name for it has many uses; for example:

At constant temperature, i.e. $T_1 = T_2$, the equation may be rewritten as a ratio of pressure to volume.

$$P_1/P_2 = V_2/V_1$$

From a dimensional analysis of the product PV an important idea is observed, hence:

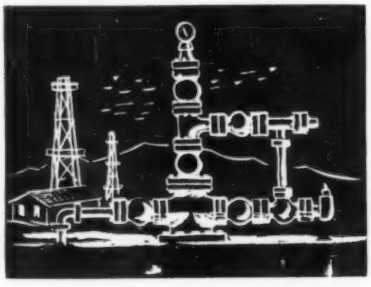
$$PV = \frac{\text{lb}}{\text{inches}^2} \times \text{inches}^3 = \text{lb} \times \text{inches} = \text{work units}$$

Thus, a change in the PV product involves a transfer of energy either as mechanical work, temperature change, and therefore heat transfer. The common experience of pumping gas and observing that the pump gets hot, and you get tired, demonstrates in a simple way that a PV change is a dynamic energy transfer process. On second thought, the illustration that one gets tired as a result of work may not be too good, because I know people who get tired without doing a bit of work, and usually the only volume change is the one about the stomach.

This discussion has been aimed at pointing out the basic relations and ideas that will be used in the following articles. When it is necessary to elaborate further it will be done. It will be helpful, no doubt, if you pick up a textbook in physics and chemistry, and briefly read the material on the laws and ideas mentioned. However, it is one of the objects of this course to present in a terse, concise manner those ideas and equations that will have the most practical use and which should be retained for everyday application after the derivations of formula have been forgotten.

For your future use and reference, *Tables 1 and 2* show the important physical constants that will be used as we discuss interchangeability, storage of gas, peak shaving and many other subjects.

The next topic of discussion will be the economics of gas from coal, the importance of the use of natural gas, and the present relation of manufactured gas to the solution of the peak-shaving problem. Though it is the real jumping off point for this series, the material presented will serve to lay the economic foundation as this article has served to lay the historic and technical foundation. ■



Thermoplastic pipe bonding

with solvent systems

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JOINTS of thermoplastic pipe and fittings made with solvent systems become effectively joined in one or two ways.

1. By fusion of the surface material which has been softened by solvent and the later hardening of this material.

2. By adhesion of solid material contained in the bonding agent to both pipe and fitting, this material forming a fairly distinct interfacial layer between pipe and fitting. This adhesion can also be effected by fusion.

The meaning of the term fusion should be taken here in a fairly ordinary sense. The term refers to the following conditions:

1. A softening of the material on two surfaces to be joined.

2. Intimate contact effected between these semi-fluid surfaces with a certain amount of intermingling of the two materials. An effective joining by fusion requires subsequent hardening of the surfaces and presupposes an attraction or affinity between the materials involved. Affinity and long term compatibility are generally taken for granted when the same or very similar materials are joined, though a degree of reserve in this regard is not undesirable. When the materials are not the same the questions of affinity and long term compatibility are very pertinent.

For convenience sake, the term adhesion is taken here to refer simply to the joining of two surfaces by means of another material placed between them.

In current practice, fits between pipe and fitting can be classified as loose or "socket" fits and tight or "interference" fits. A loose or "socket" fit exists when the smallest measurement of fitting ID equals or exceeds the pipe OD and the pipe bottoms freely in the fitting. This type of fit becomes almost necessary with large heavy wall pipe sizes which are very difficult to fully assemble if the fit is too tight. A tight or "interference" fit exists when the pipe cannot be fully placed into the fitting without encountering interference from the restricted ID of the fitting. Satisfactory upper and lower limits for interference fits vary somewhat with pipe size and schedule. As a practical matter, the fit is hardly tight enough if the pipe, before coating, bottoms very easily after slight contact with the fitting about seven-eighths of the way in. It is too tight if, after coating with the joining compound, the pipe cannot be pushed fully into and bottomed in the fitting with reasonable exertion by installers.

The type of fit has a bearing on the suitability of the joining compound. Some compounds developed primarily for use with interference fits may not be suitable for those with socket fits. They may lack the necessary solids content. Most of the compounds developed for socket fits will probably perform satisfactorily with interference fits. Fit suitability of compounds used should be a matter of common knowledge.

With interference fits the bond is effected by fusion and by adhesion. The solvent in the compound softens the surfaces to be joined to a semi-liquid state and the parts are assembled while these surfaces are in this state. In that section of the joint where there is interference, the joining is essentially that of the fusion of these surfaces. Where there is no interference there is the opportunity for the solids in the compound to join to opposing surfaces. With loose socket fits the bond is mainly effected by adhesion of the solids of the compound to pipe and fitting. The adhesion is generally accomplished by what is termed here as fusion.

It is characteristic of solvent systems that joint strength is acquired as the solvent dissipates and it is generally desirable that it dissipate rapidly once its functions of softening material and carrying solids are accomplished. In consequence, solvent systems for pipe are usually formulated for rapid solvent dissipation. This usually means that they are fast drying. And this in turn means that joints made with them must be assembled fairly quickly after the pipe and fittings are coated—their "open time" is short. It is clear that the parts should be assembled while the joining compound and the coated surfaces are in the semi-fluid state which provide necessary conditions for fusion and adhesion.

Another characteristic of solvent systems used for plastic pipe is that they generally yield better results as the gap between pipe and fitting gets smaller and further improvement is usually obtained if they meet with a proper interference fit. As a rule bond strength develops more rapidly in interference fit joints.

MAKING THE JOINT

The consistent making of good leak free joints requires planned and disciplined activity. The number of men desirable at the joint varies. A one-man crew can usually operate well at making joints with the smaller pipe sizes. With the larger sizes it has been

found advantageous to have two men at the joint.

The following points are suggested as important considerations when making joints.

1. Surfaces to be joined should be clean. The presence of dirt or grease in the joint will likely mean a void at that place. Surfaces can usually be adequately and quickly cleaned with a dry rag.

2. Surfaces should be thoroughly and rapidly coated, applying compound first to the fitting then to the pipe, since the coating dries more rapidly on the exposed pipe. Care should be taken not to coat beyond the inner shoulder of the fitting. If practicable, it is usually good practice after coating the fitting to stand it vertically, coated end down, allowing excess compound to drain while the pipe is being coated.

3. Assembly should immediately follow coating and be made while the parts are wet. Pipe and fitting should be pushed to full assembly with the end of the pipe bottoming on the shoulder in the fitting. If the fit is the interference type, it is advisable to hold pipe and fitting together for a minute or so to offset any tendency they may have to push apart. This tendency can be quite strong if the fit is very tight. After assembly, a bead of the joining compound is usually present at the juncture of pipe and fitting. It is generally advisable to quickly wipe this off. The solvent present in the bead will needlessly soften the pipe and fitting.

CURING

Adequate cure is required before the joint can be subjected to loading. Assuming conditions are such that the joint can cure to a degree that will withstand the various requirements, the question can be asked: What is the minimum cure time before one can be reasonably confident about adequate cure? Some data which bears on this question are given in *Table I*. Conclusions about field performance should not be drawn from these data, which were obtained under laboratory conditions and which deal with only one type and size of pipe. The table was made from the combined data of tests of two compounds. More data are necessary for formation of definite conclusions. Certain test results, however, are worth noting:

1. Failures did not occur immediately upon application of pressure.
2. All failures occurred long before the terminations of the test periods.
3. There was a definite time of reasonable length beyond which no failures occurred.

DISSIMILAR MATERIALS

The chief problem connected with joining dissimilar thermoplastics is the question of long term compatibility and stability of the joint. Joints of PVC and certain ABS materials have had field history for several years with apparently very good success. During the past year or two certain formulations have been used to join PVC and ABS to butyrate and high impact styrene.

HOT AND COLD WEATHER

A change in temperature affects bonding chiefly in two ways. An increase in temperature increases the evaporation rate of a solvent system. It also increases its solvent effect on material for which it is a solvent. An increase in temperature of the pipe or fitting material yields similar results. The practical effects of these somewhat opposing tendencies vary. Moderate increases usually have the net effect of reducing the open time. With large increases in temperature, penetration into some materials can become very rapid and very deep and the material so affected and softened by the solvent that satisfactory joints are difficult to make. Plastic pipe and fittings lying in the sun on very hot sunny days have been observed to reach very high temperatures. Some who encounter this situation have restricted pipe joining operations to the early part of the day. Low temperatures result in slow down of solvent evaporation and action. The temperature limits for satisfactory cold weather and hot weather bonding will vary. In addition to the materials used, the specific job requirements will markedly affect the allowable extremes in temperature. ■

TABLE I

Cure before Test	Duration of Test (200 psi)	Number of Samples	Number of Failures	Time under Pressure before Failure	Per Cent Failures
¼ hr	—	2	2	8, 10 minutes	100
½ hr	50 hr	10	4	20, 30 30, 39 minutes	40
¾ hr	25 hr	4	1	40 minutes	25
1 hr	1–8 hr 12–48 hr 4–90 hr	17	5	10, 16, 20 20, 35 minutes	29
2 hr	30 hr	4	0	—	0
5 hr	25 hr	4	0	—	0

Test—200 psi hydrostatic continuous pressure for various periods.
Test samples—Joints of PVC 1¼-in.—Schedule—40 pipe and female adapters.
Temperature Range 70 deg F - 95 deg F.
Humidity Range 60 per cent - 80 per cent.

GAS abstracts 5 AGA papers on heating and cooling

• *The heat's on for gas cooling*

IN 1954, there were four manufacturers of gas air conditioning equipment. Today, there are 12. Moreover, the eight new manufacturers are making new types of equipment and new sizes. This greater variety, plus a greatly expanded promotion program and the increasing acceptance of air conditioning as a necessity are certain to build summer load.

Two projects in the residential-size field bear watching. Whirlpool Corp. is working on an absorption unit, concentrating on four design goals: (1) competitive first cost, (2) compactness and light weight, (3) one-half Btu of refrigeration per Btu of fuel, and (4) cooling with air. Three 3-ton lab models have been built. They meet the performance goals, but the size and cost standards are still under attack. AGA and the Onan Div., Studebaker-Packard Corp., are in the final field testing stage with a 5-ton, long-life, air-cooled engine-compressor unit. Three gas companies are testing 20 units this summer. The basic engine-compressor package, ready for assembly into a complete air conditioning unit, will be available in production quantities in 1962.

In commercial-industrial sizes, there are many more developments. Statham-Swearingen Inc. has developed a lithium bromide absorption unit with a double-effect generator that reduces fuel costs nearly 50 per cent. They are building 15-ton units now and expect to build up to 50-ton models by the end of this year. Bell and Gossett Co. is building engine-driven 7½- to 150-ton equipment and has heat pumps in the planning stage. Worthington Corp. and AGA are building a 50-ton gas engine-driven heat pump that will be installed in a building this fall for extensive testing.

One of the most exciting prospects in the commercial-industrial field is the gas turbine. Many companies are trying to develop relatively small turbines, in the 150- to 800-hp range. Farthest along is the AGA-Solar Aircraft Co. project with these performance goals: (1) one Btu of refrigeration per Btu of fuel, (2) $50 to $100 per ton initial cost, (3) factory-packaged unit of the smallest practical size, and (4) long life capability and minimum maintenance, and (5) acceptable noise level. A 250-hp single-shaft, radial flow turbine was coupled to a freon compression system and the resulting 200-ton unit went into initial operation last December. Both Solar and AGA are very optimistic, since it appears that the unit will operate for long periods without maintenance and several seasons without major overhaul.

Besides Solar, many other companies, including AiResearch, Pratt & Whitney, and Boeing, are working on gas turbines to supply not only air conditioning, but heating and electricity for hospitals, schools, factories, etc.

Whereas recent air conditioning research has been of the development type, future research should be basic, seeking new ideas, new approaches, new ways. Much basic research still needs to be done on absorption systems and jet pumps. A gas window-unit-type air conditioner is a definite possibility in the somewhat distant future. It will probably come about through the use of thermoelectric or fuel cell units.

While every effort is being made to keep air conditioning research progressive, there is no need to wait for future developments. There is plenty of good equipment available right now—and in more sizes than previously.

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• *House heating research—our competition is active too*

THE trend of developments in the electric and oil heating industries may dictate gas heating equipment designs of the future, so their advances should be studied.

The electric heat pump is one of the most efficient means of electric heating, but its capacity and efficiency decrease as the outside temperature decreases. Therefore, its use is limited to mild climates, unless supplemented with electric resistance heat.

Most of the types of electric resistance heat are well known, but one of the newest is reinforcing wire. The same 1/6- to ¼-in. wire, placed 6 in. apart in a concrete slab, both reinforces the slab and provides heat.

Off-peak electric heat storage tries to beat high rates by storing heat in the home during the night. Three methods are possible. Most current is a hot water storage tank, rather bulky and expensively insulated. Water would be heated as high as 375 deg F, and would pass through a heat exchanger, as

Original presentation was at the AGA Research and Utilization Conference held in Cleveland, April 4-6.

needed. In the research stage are metal slabs located in stud spaces. They would be heated during off-peak periods and air would be circulated over them as needed. Probably even further in the future is heat storage in chemicals.

Two oil heating developments, induced draft and pressurized combustion chamber, are merely residential adaptations of features found in large steel boilers. Both eliminate the need for a natural draft and therefore enable a vent pipe to be substituted for a chimney. Besides the obvious saving in chimney cost, both are also claimed to have several other advantages: instant draft, no down draft, higher efficiency, and lower standby loss. In addition, induced draft proponents claim the advantage of having the combustion zone operating at less than atmospheric pressure at all times.

Six different oil burners are in different stages of development. The Pyrocore burner burns vaporized oil in an exceedingly small combustion chamber tube resembling an oversized gas mantle. It requires only a 1-in. vent pipe and when adapted to a boiler, exit temperatures of the products of combustion are claimed to be only 125 deg F.

The Gulf Oil Corp. burner consists of an air-aspirating nozzle, a perforated stainless steel flame tube, an air pump, an oil pump, and an igniter. Putting out 14,000 to 70,000 Btuh, it is said to be able to convert gas-designed equipment.

Shell Oil Co.'s blue flame burner puts out the same range of heat and, with 12 to 14 per cent Co_2, is said to be clean and silent. It atomizes, then vaporizes the oil, producing an oil gas which is mixed with secondary air. The Bottrill Oil Burner uses electrical initial ignition, an induced draft, and produces from 14,000 to 200,000 Btuh. It mixes oil and air, preheats them in a glass tube in the combustion chamber, then burns them in the refractory-lined chamber. The Palco oil burner also preheats an air-oil mixture in a vaporizing chamber. The mixture is blown through ports in the burner where it burns with a blue flame, producing 35,000 Btuh. The Waller oil burner converts fuel oil into a stable gas which, it is claimed, can be burned in gas equipment with no chimney, merely a 1-in. vent pipe, since flue temperatures are only 125 deg F. It is further claimed that this burner can use just about any kind of liquid fuel and requires no adjustment from one fuel to another.

The gas industry should be striving for the features frequently claimed by many of the preceding oil and electric units: (1) elimination of chimney cost, (2) higher combustion efficiency, (3) lower standby loss, (4) adaptability to add-on rooms and where space may be heated infrequently, and (5) combination equipment for year-round air conditioning.

E. T. SELIG
Director of Engineering
Burnham Corp.

• *A comparison of gas vs. electricity for residential heating*

AT the close of 1960, 700,000 U. S. homes were electrically heated. Electric utility executives have estimated that by the close of this decade, there will be 4 million electrically heated homes, or 7 per cent of all homes.

Although the usual electric industry recommendation is 6 in. of insulation in the ceiling, 4 in. in the walls, and 2 in. under the floor, one writer in *Electric Heating & Cooling Magazine* recently recommended 14 in., 8 in., and 10 in., respectively.

NEMA really claims an efficiency of 130 per cent for resistance heating. Quite obviously, this is impossible. So any apparent excess over 100 per cent can only be due to heat gains, to maintaining unusually low average house temperatures by turning off heat in certain rooms not in use, and to limiting the fresh air infiltration below that needed for health and comfort. At least one electric utility has abandoned the NEMA formula because of bills way over estimates and has gone back to 100 per cent efficiency.

A simple way to show customers how expensive electric heating can be is to show the operating cost of both gas and electric heat on a one-million-Btu-of-useful-heat basis. Multiply the gas cost per therm (100,000 Btu) by 10 and divide the result by the percentage of efficiency, 0.75. To find the comparable cost for electric resistance heating, multiply the rate per kilowatt-hour (3413 Btu) by 1 million and divide the result by 3413. In this case, the efficiency is rated at 100 per cent, so it does not enter into the calculation.

Two recent studies show the comparative operating costs of gas and electricity. Equitable Gas Co. computed the cost of heating a moderate-sized, well-insulated house with a heat loss of 29,300 Btuh. Natural gas, at the rate of 75.8 cents per Mcf, would cost $60.64 for a season. Electric resistance heating, at 1.65 cents per kwh, would cost $297.01. That's a cost ratio of 4.9 to 1. Northern Illinois Gas Co. made a well-documented 12-month survey of a three-bedroom electrically heated house that had been thoroughly instrumented for testing. When it finished, it estimated how much the same house would have cost to heat with gas. The house had a heat loss of 27,056 Btuh and the area had 6953 degree days. With electricity again at 1.65 cents per kwh, the actual cost for the year was $250.64. With gas at 9.2 cents per therm, the estimated cost was $63.46. That's a cost ratio of 3.95 to 1.

The cost of owning the equipment is another story. In a study conducted by Northern Illinois Gas, electricity brought lower figures than gas, but only when gas air conditioning was included. The owning cost of an electric resistance heating installation plus air conditioning was estimated at $198.02 per year, including $25.92 for heating equipment, $123.18 for air conditioning, $20.73 for wiring, and $28.19 for extra insulation. For the electric heat pump, the total was

$257.86, including $208.94 for the heat pump $20.73 for wiring, and $28.19 for extra insulation. The all-gas owning cost was $343.77, including $36.85 for the furnace, $299.44 for the air conditioner, $3.74 for piping, and $3.74 for flues.

Combining total heating and cooling energy costs with owning costs gives the complete, accurate, realistic picture. Northern Illinois worked out figures for a typical three-bedroom house, using its local climate, rates, and costs. It determined that total heating and cooling costs for a fully insulated all electric home heated and cooled with a heat pump were $847 per year. Using resistance heating and central electric air conditioning, this figure jumped to $1064. Using gas for both heating and air conditioning, this figure dropped to $700. Combining gas heat with electric air conditioning further lowered the figure, to $591. The most recent study along this line, conducted by Washington Gas Light Co., revealed a similar superiority for gas when total costs were compared: heat pump heating and cooling, $662; electric resistance heating and electric air conditioning, $537; gas heating and cooling, $506; gas furnace and electric air conditioning, $396; electric resistance heating only, $367; and gas furnace only, $231.

Clearly, if owning and operating costs governed all decisions, very little electric heat would be sold.

W. H. LOVING
Technical Service Sales Manager
Washington Gas Light Co.

• *Gas heating estimates: the new way*

THERE has long been a lack of authenticated information covering the competitive situation between gas heat and electric heat, primarily because of the electric industry's failure to substantiate its claims. AGA's Committee on Comparison of Competitive Services, therefore, authorized a thorough study of gas-fired warm air systems, resistance heating, and heat pumps.

To maximize the reliability and applicability of the data, four climate areas were chosen, spanning a wide range of degree day figures: Albany, Ga., 1670; Washington, D. C., 4333; Elizabeth, N. J., 5450; and Butte, Mont., 9760. Data were obtained from 159 gas-heated homes, 50 resistance-heated homes, and 24 heat-pump-homes. The houses were a good cross section, picked at random from utility files. Complete data were secured for each home, from utility meter books, from the weather bureau, and from professional engineers.

The study started out to answer five questions and the committee feels it has. The five basic facts to emerge are: (1) A single nationally applicable method of estimating fuel consumption is possible. (2) Internal heat gains could not be predicted but their effects are predictable; however, external heat gains could not be evaluated and their satisfactory evaluation appears impossible. (3) Because of the inaccuracy of homeowner reports, thermostat settings do not appear to be reliable factors in preparing fuel consumption estimates and no attempt was made to correlate consumption with thermostat settings. (4) No definite correlation could be established between furnace oversizing and consumption because the data were limited, ratings not always reflecting true input; however, more data promises to permit a satisfactory correlation. (5) Homeowners generally are neither reliable reporters of the degree of comfort provided by their systems nor the conditions under which these systems operate.

Both of the two annual fuel consumption estimating methods in common use today have some shortcomings. The calculated heat loss method uses the seasonal efficiency of the heating system, a figure open to much discussion, if not argument. The degree day method creates some application problems when the estimator fails to understand it completely and leads to the desire for fewer auxiliary correction factors.

The irreducible minimum was determined to be:

$$\text{Annual consumption of fuel or energy, Btu} = \frac{HL \times K}{TD}$$

where HL is the design heat loss of the house, Btuh
TD is the design temperature difference, deg F.
K is an experience factor, a function of the area's degree days.

The "K" is the key. It was established by dividing the total energy and fuel input to every residence (heating, cooking, water heating, lights, and other miscellaneous usages) by the residential heat loss per degree of design temperature difference. The field data thus provided a K value for every house for each season in the study. This K, however, is based upon the total input to the house and must be reduced to represent heating input only. The study revealed that the heating K value could be obtained by merely taking 77.5 per cent of the total K value. Accurate average heating estimates can then be made for any area, once experience determines the K value for that area.

It is important to note that the estimate will be an average. Theoretically, half of the fuel bills should fall below that average with satisfied customers resulting—and half should fall above the estimate with dissatisfied customers resulting. This predicament pinpoints the difference between the proposed estimating method and all other methods. With this method, estimates can combine any degree of accuracy with any probability of satisfaction, all hitherto loose ends being tied together with standard statistical methods. The study determined that if an estimator believes the customer to be tolerant enough to be satisfied with a bill 10 per cent over estimate, and that if he is willing to take an 80 per cent chance of the customer being satisfied, he can multiply the K heating value by 1.122. A prepared graph indicates similar multipliers for various probability of satisfaction and tolerance for error percentages. Thus, the estimator can give the most competitive gas heating figure consistent with his desired probability for satisfaction

and his customer's probable tolerance for error.

For electric heating estimates, NEMA has been promoting a very similar formula, K's place being taken by degree days multiplied by the constant "C." Some electric interests recommend that C be 18.5 while others suggest 12. In this study, values for individual homes ranged from 3.6 to 48.5, the high and low averages being 26 in Albany and 6.8 in Butte. The committee is confident that when enough electrically heated homes are available to provide conclusive results, accurate electric K factors can be determined.

In any specific area, only one K exists for any one fuel. Once these Ks are determined, simplified, accurate average heating cost comparisons can be made.

W. R. SARNO
Assistant Utilization Engineer
American Gas Association

• *Improving gas supplemental heaters*

DUE to circumstances in the heating industry, a major part of AGA's domestic heating research has been centered on central systems.

Three facts now make supplemental heating worthy of concentrated research efforts. First, a 10-year market study shows that 1.6 million room heaters are sold each year, as compared to 1.3 million furnaces, boilers, and conversion burners. Second, ever-increasing family size and the trend to home entertainment via television and hi-fi has resulted in frantic efforts to expand living space by adding on rooms and converting porches, breezeways, garages, etc. Properly heating this additional space with gas is sometimes most difficult because of the somewhat limited variety of available equipment. Third, the problem of supplemental heating is being increasingly solved by electric heaters, whetting the electric industry's appetite for heating and pre-selling customers on electric heat when their supplementary electric heating works satisfactorily in a limited or occasionally used installation.

The cumulative effect of these facts has been PAR research project DA-9-HA. In addition to the basic fundamentals of safety, efficiency, and proper heat distribution, there are five design goals: (1) Input of 20,000 Btuh or less; (2) easy installation in new or old construction; (3) a sealed combustion chamber to assure adequate combustion air and dispose of combustion products; (4) attractive or inconspicuous appearance; and (5) reasonable production costs.

A test room is being built at the AGA laboratories in Cleveland to test various gas and electric heaters under actual operating conditions. A movable wall allows the room area to be changed to match heater size. The outside walls are air conditioned to simulate outside temperatures. And, adjustable equipment will make it possible to take temperatures at all locations in the room.

The first concrete results of this project were shown at the Hall of Flame exhibit in Atlantic City last October. The first prototype heater is a 10-ft long direct-fired, baseboard convector unit with an input of 16,000 Btu. With the exception of a 9-in. by 14-in. control cabinet, it looks like a conventional hot water or steam convector unit, extending about 4 in. into the room. A single port, flame-retention-type burner fires into a ⅞-in. diameter stainless steel tube enclosed in a 1¼-in. finned heat exchanger through which the products of combustion return to the exhaust blower. Test indicates 80 per cent efficiency with heat delivered by natural convection. The second prototype burner is an 11,000-Btu radiant heater. Nineteen inches high, it is 14¼ in. wide and extends into the room 3½ in. Two 3-in. by 5-in. radiant burners, operating at 1600 deg F, are placed behind an etched glass panel which seals the combustion chamber and reduces surface temperatures to 700 deg, meaning that a safety grill is necessary. Also operating at 80 per cent efficiency, this unit supplies half of its heat by radiation and half by convection. It may be mounted at any height.

Three additional supplemental heaters are now in the works at the AGA labs and several more are planned before the project is completed.

C. L. ELLIOT
Supervisor, Residential Heating Div.
Cincinnati Gas & Electric Co.

regulatory • *Continued*

from page 12

therefore, are generally undesirable, unnecessary and incompatible with the public interest for the due and proper development of natural gas service by natural gas companies. However, limited price-redetermination provisions appear appropriate to meet the difficulty of pricing for long and unpredictable periods and to encourage the negotiation of long term contracts." ■

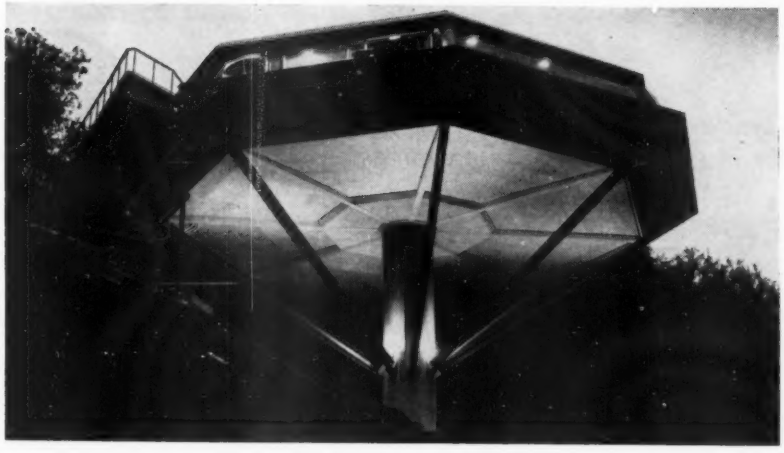
corrosion • *Continued*

from page 23

at all, that the line has leaks from one end to the other, and that he'd better get back and see what the trouble is right away.

What happened was this: at the time the protection was installed, the line had already developed such a leak rate, and such a reputation, the the operating pressure had been reduced from the original design value of 800 lb to only 400. Then, after the passage of two years, the increase in demand began to crowd the capacity of the line. Since there had been no leaks in two years, the line was obviously in good condition. So, the pressure was raised to 600 lb. Immediately, a dozen or so thin spots, which were strong enough to hold 400 lb but not 600, and which had been in just that state of suspended corrosion for two years, all let go at once! At least three cases are known, of each of which the above is an almost exact description. ■

GAS DISTRIBUTION NEWS



In orbit with an editor

"Electricity is the fuel of tomorrow," they say, all night and all day. But farther out than this one, houses just don't get—without going into orbit. And this flying saucer son of a giant mushroom perched up in the Hollywood Hills is all gas!

Called the "Chemosphere House," the structure was jointly sponsored by Chem Seal Corp. of America and Southern California Gas Co.

Twice as big as the average house, this 2200-sq ft, 60-ft diameter octagon sits on a 5-ft thick, 30-ft high *hollow* concrete column.

"The basic idea of building the home on top of a concrete column was to provide a footing stable enough to withstand earthquakes, landslides, high winds, and other disturbances of man and nature."

That's what the news release supplied at the press showing said. But when your GAS editor was on the scene, he never really put all of his weight down. And when a group of six gathered on one edge of the living room to take in the 360-deg view, we did a hurried (but diplomatic!) cocktail-party cha-cha to the fourth bedroom on the opposite side to help counterbalance the whole thing.

Another item that caused your Early American editor no small amount of concern was the paragraph about the house having virtually no nails, screws or bolts. Everything, it seems, is held together with Chem Seal chemical adhesives and sealants.

Of course, having to take a four-passenger cable car up to the house from the nearest bit of land flat enough to carve out a road—and that's 125 ft down—didn't help any either.

Exciting to the visitor from its Arkla all-year air-conditioning to its zestful, zany zoom-lines, this little project must have been just as exciting to the craftsmen who built it.

After getting back down to earth, we were no longer prepared to argue whether gas or electricity is the energy source of tomorrow. But we were betting our son's hastily borrowed space helmet that gas is the fuel they'll be using 100 years from tomorrow—and the next time they get us up in that thing!

Storage area testing launched

Construction is underway on a pipeline that will permit testing of a proposed underground gas storage facility in the Mahomet, Ill., area.

Emory A. Manlove, vice president in charge of operations for Peoples Gas Light & Coke Co., said the 7.5 mile, 12-in., temporary line will transport gas to the storage area from the Natural Gas Pipeline Co. of America system.

The Illinois Commerce Commission approved the testing and development through the pilot stage. Storage rights have been purchased for all of the land in the 5000-acre primary test area with the exception of one tract near the southern edge.

If tests prove successful, Peoples Gas will ask commission approval to develop the reservoir as an adjunct to its distribution system serving Chicago. This step would include construction of compressor facilities and a pipeline to the Chicago area.

Manlove said the storage facility will enable Peoples Gas to furnish additional gas to its customers on peak days without a corresponding increase in daily pipeline flow gas capacity.

Greeley Gas extends

Greeley Gas Co. has purchased assets of Minnesota Natural Gas Co. With the purchase, Greeley adds 5250 customers in four southern Minnesota towns: Worthington, Windom, Lakefield, and Mountain Lake.

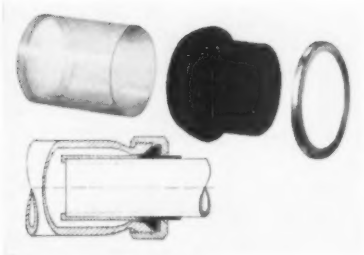
The acquisition brings to more than 27,500 the total residential, commercial, and industrial customers served by Greeley Gas Co., which serves 36 Colorado and Kansas communities.

(*Continued on page* 88)

GAS DIGEST

New Products and Trade Literature

For more data on any of these items use the Readers' Service Card on pages 85, 86

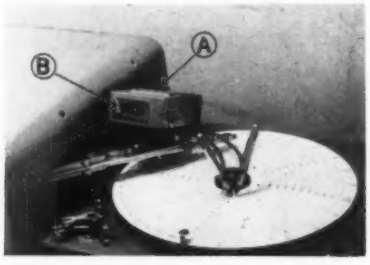


1. Insulating joints

Normac's improved insulating couplings and fittings incorporate a semi-insulating gasket and nylon insert combination, or a full rubber insulating gasket (GEC-370). Nylon has a very high dielectric strength, while the insulating gaskets have low carbon content for maximum insulation.
Norton McMurray Mfg. Co.

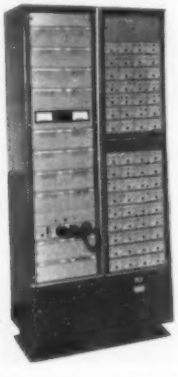
3. Tire design

A new tire design combines off-the-road advantages of flotation tires with long mileage in highway service (GEC-790). Harmo's new tire is particularly suitable for equipment that must travel long distances at high speeds on highways, then cross open-field country.
Harmo Tire & Rubber Co.



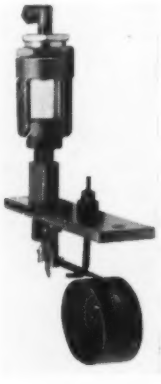
5. Flow chart counter

The Reset-Duad counter is for use with orifice flow chart integrators (GEC-560). It has two separate counters (A and B in the photo). Its two operations are: 1. Totalizing each individual chart resetting to zero after each completion. 2. Accumulating individual and chart extensions for batch totals.
Flow Measurement Co.



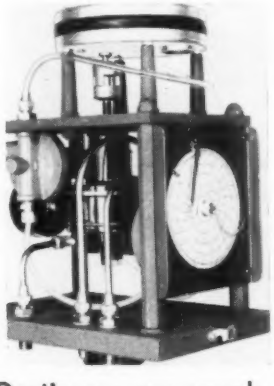
2. Microwave package

Motorola's newly introduced transistorized microwave package includes RF, multiplex, telegraph carrier, and alarm equipment (GEC-140). The line, designated Series 50, operates in the 6000-mc region. Pull-out drawers enable "in service" maintenance from front of the racks.
Motorola Inc.



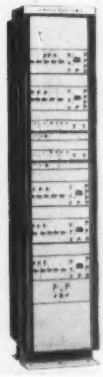
4. Automatic fill valve

McCord's A-30700 automatic fill valve for force feed lubricators has been introduced (GEC-170). The new valve keeps all oil reservoirs filled automatically. It is used for automation of gas engines and compressors, eliminating need of manually filling the lubricator reservoir.
McCord Corp.



6. Continuous gas sample

ARCCO has a new continuous gas sample for the accurate determination of chemical and physical properties of a gas (GEC-540). The ARCCO Model GR will—over a period of 7 days—accumulate at a constant rate a sample of gas to a final pressure at or near 300 psig from the sample source.
ARCCO Instrument Co.

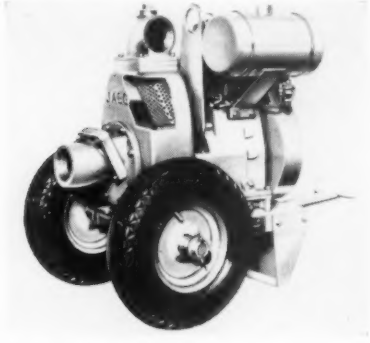


7. Microwave system

G-E is marketing a new error-reducing transistorized microwave relay system (GEC-140). Built for high channel capacity and medium-to-long-haul use, the RF-7 transmits at frequencies from 5920 to 8400 mc. It is said to provide a 10-fold increase in transmitter output while requiring 50 per cent less power input.
General Electric Co.

8. Pig, sphere finder

F. H. Maloney has developed a new unit for pipeline sphere and pig detection (GEC-370). The Mark IV Sphere-Here is a completely pressure balanced unit, giving accurate detection in any gas or liquid line. It can be installed in any position on pipe and is designed to detect with equal response from any direction.
F. H. Maloney Co.



9. Trash pumps

New self-priming centrifugals that pump big volume and also positively eject trash are announced by Jaeger Machine (GEC-660). Designed to handle any dewatering job, the trash pumps feature "Posi-Jector" to assure positive ejection of debris when pumping dirty water.
Jaeger Machine Co.

10. Gas line filter

Air-Maze has developed an easy-to-clean consumer gas line filter (GEC-500). It is designed to prevent clogging of furnace and pilots by eliminating dirt, pipe scale, and other foreign matter from gas lines. One bolt loosens the two aluminum sections; the filter can be washed in plain water and detergent.
Air-Maze Division

11. Exhaust snubbers

Burgess-Manning has completely redesigned and re-engineered a new series of engine exhaust snubbers for reduction of noises of engines, blowers, compressors and vents (GEC-581). Each one of the series is designed for a particular level of noise suppression. The new series is available from 8-in. through 30-in. pipe sizes.
Burgess-Manning Co.

12. Automatic welding

Automatic welding in the field—without rotating pipe—is possible with a Price-Crose-Perrault-Hobart developed automatic welding machine (GEC-870). Operator can control both fixture and welding head to compensate for variables. Weld zone is visible at all times. Controls are preset and operated by pushbutton pendant.
Hobart Brothers Co.

POKER? Play to win!

How would you play this hand?

One chance in five to fill this flush, so be sure the pot is at least five times as big as the bet. If you haven't passed openers, raise. In general, a timid "calling" game is a losing game. Play percentages, but push them hard.

Here's a sure winner from FORD:

Latest addition to the world famous Fordson diesel line of tractors—the new Fordson Super Major. New disc brakes, differential lock, comfort seat and many other new features give a new peak in Fordson performance.

Still the same reliable engine, however—the dependable 42.6 drawbar H.P. engine which has earned a reputation for fuel economy unmatched by any other engine in its class.

Fordson Dexta Diesel tractor is better, too. Improved hydraulic system, transmission and styling make it a better buy than ever before. Get details from your Ford Tractor Dealer, or write:

Tractor and Implement Division
Ford Motor Company
Birmingham, Michigan

Ford
TRACTORS
EQUIPMENT

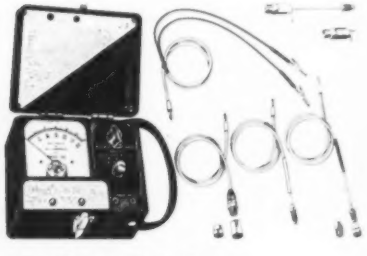
GAS DIGEST

13. Control, line valves

Spanseal is a group of control and line valves from Ledeen (GEC-820). Features include bubble-tight shutoff, versatile internal flow configurations, low shifting force, small linear valve movement, adaptability to a wide variety of pilot attachments, non-interflow between valve ports. Available for 1500 psi pneumatic and hydraulic service and —40 to +250 deg F temperature range.
Ledeen Inc.

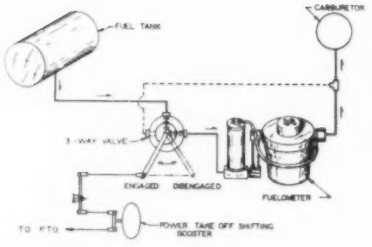
14. Limit control

General Controls has introduced an economy model of the L44 fan and limit control with single element Klikswitches for warm air furnaces (GEC-190). Limit settings of the new L44F are fixed at 175, 200, or 250 deg F with standard adjustable fan settings. A summer fan switch provides for continuous or automatic fan operation.
General Controls Co.



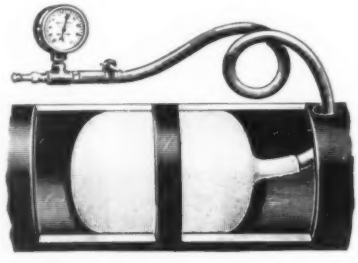
15. Control tester

Baso has a new multi-purpose, highly accurate instrument for on-the-job testing of gas burner controls (GEC-190). Test kit No. 120-2 checks dropout values of thermoelectric power units, MV output of thermocouples and pilot generators, performance of pilots during main burner operation.
Baso Inc.



16. Fuel meters

Fuelometers record how much gasoline is used for non-taxable off-highway operation of motor vehicles (GEC-790). The Servis Fuelometers are mounted on vehicles between the fuel pump and the carburetor. They record the amount of fuel used for over-the-highway travel and for powering take-off equipment.
Service Recorder Co.

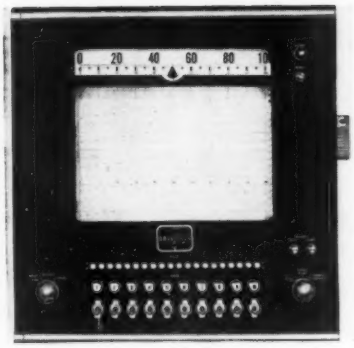


17. Gas stoppers

Balloon-like stoppers with Dynel fabric covers provide quick shutoff and fewer problems in making repairs on mains (GEC-500). Specially designed rubber bags are fitted with tire valve, nipple, and hose clamp. Inflated, it serves as a temporary valve, shutting off gas flow.
Safety Gas Main Stopper Co.

18. Compressor cylinder

Clark's pipeline compressor cylinder has an acoustical system that eliminates separate external headers and accompanying pulsation problems (GEC-160). With En Bloc design, suction and discharge headers open to sides of cylinders and are directly connected to lead-in, lead-out lines.
Clark Bros. Co.



19. High-speed scanner

Bristol's new 200 point transistorized alarm scanner is capable of scanning up to 200 measured variables at the rate of one point per second (GEC-750). In addition to the advantages of high speed scanning, the instrument features long life under continuous operation, quick alarm condition setting, and indicated scan cycle.
Bristol Co.

20. Needle valve

Dragon Engineering has broadened its line of panel-mounted needle valves by the addition of a smaller and more compact soft seat valve for pneumatic and metering services (GEC-200). The valve assures absolute bubble tight sealing against all gases at pressures to 6000 psi.
Dragon Engineering Co.

21. Zone valves

White-Rodgers new series of zone valves is described as performing with "the unfailing quality required for trouble-free hydronic zone control" (GEC-820). Two styles are offered: the Zone-A-Flow straight-through type for multiple-pipe systems; and the Zone-A-Loop diverting type, for single pipe installations.
White-Rodgers Co.

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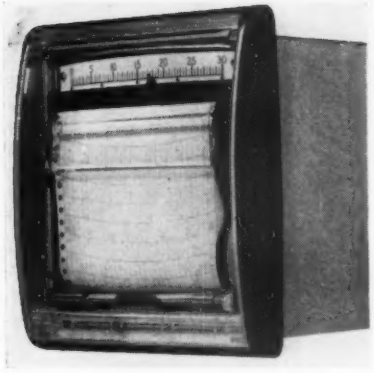
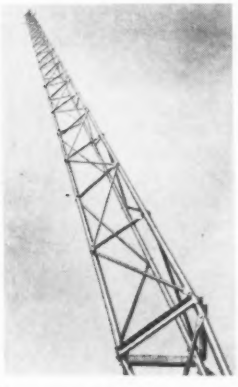


22. Transistorized telemeter

Foxboro has an all-electronic telemetering system (GEC-750). Standard 2-second cycle provides high scanning speed and more sensitivity to rapidly fluctuating measurements. The electronic system has few moving parts; no mechanical cam followers, no clutches, and no mercury switches.
Foxboro Co.



23. Communication towers

A new line of two-way radio communications towers from Motorola range in height from 10 to 500 ft (GEC-140). The new line includes eight bolted or welded guyed towers and one self-supporting model. Towers in all seven models have a windload rating of at least 30 lb per sq ft.
Motorola Inc.

TRADE LITERATURE

24. Engine performance

Clark's Bulletin 205 discusses two-cycle gas engines, with particular emphasis on their performance characteristics in variable-speed, variable-load applications (GEC-160). Descriptions of both low speed and overload performance are substantiated by performance curves from actual test data.
Clark Bros. Co.

25. Gas scrubbers

Although originally designed to remove entrained moisture from steam, Hi-eF scrubbers have been field proven to solve gas engineer's wet or dry entrainment problems (GEC-720). Bulletin 601 describes the scrubbers, which operate at line velocities and low pressure drop. Low first and installed costs, no maintenance, compact design, no moving parts are features of the scrubbers.
V. D. Anderson Co.

26. Field regulators

An 8-page brochure outlines features of Reynolds' entire line of high pressure field gas regulators (GEC-700). The booklet, part of a current catalog revision, contains complete information on high pressure, intermediate, and field regulators.
Reynolds Gas Regulator Co.

27. Primers and enamels

The complete family of Bitumastic primers and enamels for pipeline protection is described in illustrated Bulletin T-204 from Koppers (GEC-130). Divided into three sections, the bulletin includes a color-coded enamel selector as an aid in selecting the correct protective coating system for specific ranges of field conditions.
Koppers Co.

28. Rotary compressors

Latest models of Davey 600-cfm rotary compressors are presented in Bulletin E-263 (GEC-010). Contents include a comprehensive outline of operating principles of the Davey multiple stage rotary compression system, with emphasis upon Perma-Vane blades.
Davey Compressor Co.

29. Supercharged engines

Bulletin 77-2 describes the operating characteristics of Cooper-Bessemer's 12- or 16-cylinder supercharged LSV engines (GEC-160). This is the latest literature published on the versatile, V-type 4-cycle engines which are setting performance records under severe sustained-hp operation demands.
Cooper-Bessemer Corp.

30. Plug valves

Walworth's Rolotork lubricated plug valves are described in a new 2-color, 16-page brochure (GEC-820). The brochure explains in detail, through copy and unusual cutaway illustrations, exactly how Rolotork works.
Walworth Co.

31. Incinerator burners

Eclipse Fuel's improved line of packaged incinerator burners with input capacities up to 900,000 Btuh is presented in a new bulletin (GEC-440). The new Eclipse 800 series SIB burners come in eight sizes.
Eclipse Fuel Engineering Co.

32. Corrosion ruler

A new circular slide rule-calculator tells the corrosion engineer how much pipeline outer wrap he needs for any job (GEC-130). The calculator also tells him the total cost of his materials and how he can save by specifying Fiberglas outerwrap.
Owens-Corning Fiberglas

33. Ball valves

Comprehensive information on manually operated and pneumatically operated ball valves is contained in Catalog 1200 from Hills-McCanna (GEC-820).
Hills-McCanna Co.

Lancaster non-crack
SYNTHETIC DIAPHRAGMS

- Quality proved from coast to coast.
- Rolls smooth without wrinkles.
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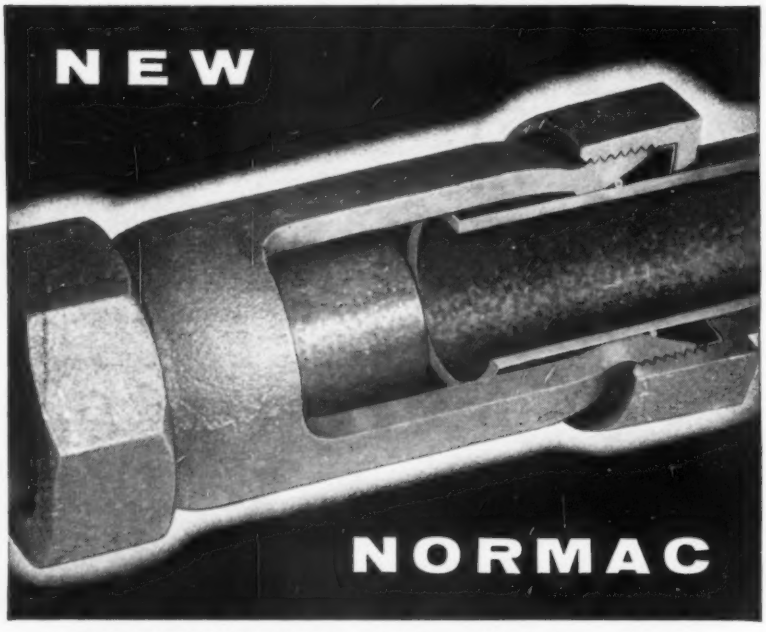
There's a definite reason for the shift to Lancaster Non-Crack Synthetic Diaphragms. Ask our salesman why.

Lancaster METER PARTS CO.
P. O. BOX 378 • LANCASTER, OHIO

Meters rolling off line in Russellville

Arkla's meter division in Russellville, Ark., is turning out gas meters at a 100-per-day rate. General Manager E. R. Gilmore says the plant's capacity is 500 meters daily.

In the photo (right), the new Arkla V-250 gas meter moves through rigid tests for accuracy. At left rear is a battery of provers for rate flow. In the foreground meters undergo low light or low flow rata tests. Other tests for the meters are hydrostatic and differential checkups.



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The most complete line for copper or plastic tubing in ⅝, ⅞, 1⅛, 1⅜ O.D., 1¼ I.P.S.

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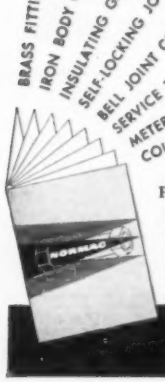

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PERMANENCY Rely on NORTON-McMURRAY for the finest! NORMAC continues to modernize and improve couplings and fittings in step with latest gas distribution demands. 22 years experience concentrated on ONE purpose . . . the BEST! Today, major gas distribution companies say "NORMAC" to define their standard of quality.

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919 N. Michigan Ave • Chicago 11, Ill.

Lone Star honors community service

The "surpassing importance" of community service was emphasized by L. T. Potter, president of Lone Star Gas Co., at the company's recent management achievement awards dinner.

Twelve district managers in Lone Star's general division of distribution received plaques for outstanding performance in the field of management.

Men honored included: Texas—Roy Porter, Colorado City; Bill Milam, Commerce; C. M. George, Fredericksburg; Floyd Harris, Garland; W. L. Routt, Gatesville; Carter Haley, Palestine; Harry King, San Angelo; Roy Day, Taylor; and Hal Dyer, Wichita Falls. Oklahoma—Clyde Clack, Durant; Hubert Westfall, Frederick; and Sterling Campbell, Idabel.

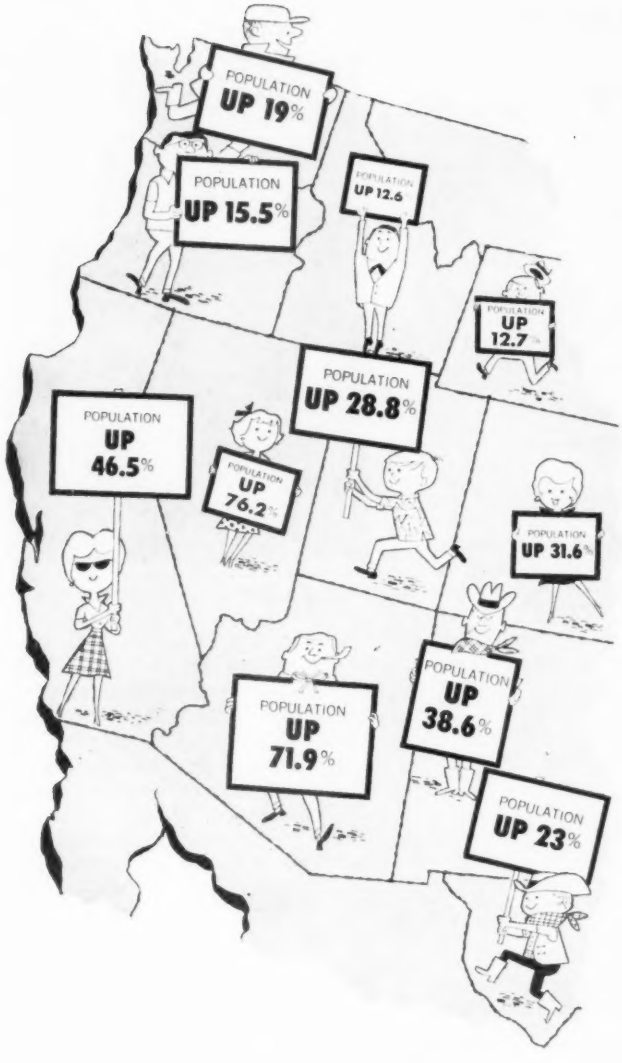
Southern Union opens Austin service center

A four-hour open house marked the official opening of Southern Union Gas Co.'s new ultra-modern service center in north Austin, Texas.

The new service center contains over 26,000 sq ft of floor space. More than 50 gas lights will be installed on a masonry wall which will surround the 7-acre tract on which the plant is located.

Housed in the pre-fabricated all-steel plant are Southern Union's engineering, service and installation, pressure control, maintenance, inspection, and corrosion departments. Other space is devoted to offices of the general superintendent, district storekeeper, area measurement superintendent and area utilization engineer. Also, employee meeting and training rooms, meter testing shops, warehouse facilities and gas appliance testing rooms.

The West rockets ahead with ***more and more energy*** *from natural gas*



Ten-Year Population Growth Figures from U.S. Census, 1950 and 1960.

Growth and expansion continue to be the two big activities in the West—both for the people who live and work and play in this booming region, and for El Paso Natural Gas Company which supplies natural gas to so many of them for so many purposes.

Much of the story in detail is in the Company's Annual Report for 1960, just out.

The growth part of the story for El Paso, in a sentence:

In 1960, El Paso furnished customers in 11 Western states more than 1¼ trillion cubic feet of gas—an all-time record and over four times as much as was delivered just a decade ago.

The growth story in the 11 states is a climb in population to a total of 35,718,636 (1960 census), up 33.9 per cent in the past 10 years and still rocketing.

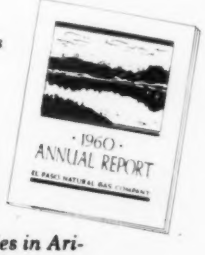
As for expansion—

Demand for El Paso's services and products by long-time customers keeps increasing as families and communities and businesses grow. Then add the millions of new people, more new businesses and all their needs. Add, too, the ever-increasing realization by everyone of the economy and conveniences of gas as a source of dependable energy for a multitude of uses.

And El Paso is expanding to meet this need. To supply its customers—including such growth areas as California—it has developed the most diversified gas supply of any company in the nation. Today, El Paso's pipelines are connected with the principal producing areas of the West and Southwest, in addition to vast reserves in Canada.

The Company's Annual Report reviews a number of important projects recently completed, and reports progress on others from Canada to the Mexican border.

For copies of El Paso's 1960 Annual Report write to: El Paso Natural Gas Company, El Paso, Texas



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El Paso Natural Gas Company provides natural gas to industrial customers and distribution companies in Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, West Texas and Wyoming.

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Austin Recording Gas Titrator Model 4010

The fully automatic Austin Gas Titrator 4010 is designed for continuous on-line measurement of sulfur in natural gas and plant process streams. Developed for corrosion and odorant control analysis in transmission and distribution systems, the 4010 continuously records on a strip chart its analysis of sulfur compounds. This accurate, reliable analytical instrument is adaptable to virtually any installation in the natural gas, LP gas, petrochemical, and chemical processing industries.

ANALYSIS CYCLE:
Complete analysis and recording of major sulfur constituents once each hour

RANGE (H_2S):
0 to 0.5, 0 to 2.5 grains/100 SCF Full Scale

For additional information write:

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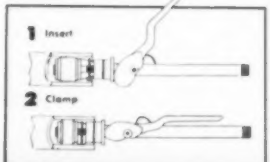

FREE LITERATURE

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You can save 40 minutes per pipe section tested
With 6 years of utterly SAFE experience, Anderson Plugs save about 40 minutes (on 4" pipe) per pipe section tested by replacing cumbersome end welding and cutting. If each of your trucks makes only one test per week, the tool investment will be completely paid out within a year.

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P. O. Box 455, Santa Cruz, California
Manufacturers of time-saving Anderson Test Plugs and Pipe and Tubing Pullers

Peoples Chicago construction launched

Work on the southern section of Peoples Gas Light & Coke Co.'s $20 million interstation gas main is under way.

Work began at the same time at both ends of the 11-mile portion of the 36-in. line.

Last year the company laid 8 miles of line. Construction in 1962 will link the 1960 and 1961 segments. When completed, the line will intersect medium pressure mains and will interconnect with distribution pumping stations.

Photo shows Peoples Gas chairman Remick McDowell (left) and Chicago Mayor Richard J. Daley breaking ground for the start of construction.

Safety record continues to improve

The employee safety record in the gas industry improved in 1960 for the 13th straight year, according to a preliminary survey by AGA.

A sampling of representative companies indicates that accident frequency in 1960 was at an all-time low—and nearly 13 per cent lower than in 1959.

The report shows that there were 6.24 injuries per million manhours in 1960 which caused an employee to lose one or more work days. The record high was in 1947 when the frequency was 21.86 injuries per million manhours.

Mich Con plans service to 8 new towns

Michigan Consolidated Gas Co. plans to extend gas service to eight Michigan communities.

The $1 million-plus facilities will serve the communities of Willis, Kent City, Hart, Shelby Grant, Paris, Manton, and Kingsley.

Hugh C. Daly executive vice president of Michigan Consolidated, said his company still must obtain franchises, but that service was "virtually assured."

The extension will require 44 miles of gas distribution and supply mains and 20 miles of service piping for an estimated 1550 customers.

Honeywell revises flow meter handbook

Brown Instruments division, Minneapolis-Honeywell Regulator Co., has published a new edition of its "Flow Meter Engineering Handbook." The new edition has basic flow calculations rearranged for easy reference and includes primary measuring devices other than orifice places.

The 170-page book includes schematic diagrams, graphs, charts, tables and other data. Separate chapters on steam, liquid and gas flow calculations contain all data necessary to calculate or check an orifice plate installation.

Additional information on the book is available from Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Price: $7.50.

Cheaper thermoelectric devices sought

Under an agreement with AGA, Transitron Electronic Corp., Wakefield, Mass., has begun a project aimed at reducing the cost of thermoelectric devices to make them commercially practical.

The goal of the project is to develop thermoelectric modules or units that will provide power at less than $1 per watt. At present, cost per watt of experimental models of appliances using thermoelectric couples does not permit mass production.

Transitron, manufacturer of semi-conductors, plans to develop power modules that can be produced for inclusion in various gas appliances.

Don't take our word for it—try a new RIDGID Flaring Tool! See if you don't get smoother, stronger, more uniform flares . . . in less time and with less effort than ever before!

Then, compare this new RIDGID Flaring Tool, feature-by-feature, with any flaring tool you've ever seen or owned:
• Feed releases automatically when flare is fully formed. • Reversing feed screw burnishes flare. • Hardened steel die bars are precision-machined. • Large, comfort-grip feed screw handle turns easily. • Precision-ground, hardened steel flaring cone, eccentrically mounted in precision bearings, produces rolling action for even metal flow . . . gives uniform flare walls without galling. • Tubing hole sizes are clearly marked. • Easy sliding rugged malleable yoke serves as stop for tubing to give correct flare size. • Yoke clamp screw fits into centering hole . . . locks bars, yoke and tubing into perfect alignment. • Stop pins keep yoke on die bars at all times . . . yoke can't slide off.

3 Models:	RIDGID No. 457 for 45° flares, ⅛" to ⅝" O.D. (7 sizes) RIDGID No. 459 for 45° flares, ⅛" to ¾" O.D. (9 sizes) RIDGID No. 376 for 37° flares, 3/16" to ⅜" O.D. (6 sizes)

See and try these new RIDGID Flaring Tools. Your Supply House has them.

RIDGID Work-Saver Pipe Tools

RIDGID

The Ridge Tool Company, Elyria, Ohio, U.S.A.

Straight as a ramjet—no ricocheting gas molecules here. You're standing inside the main flow passage of a Maxitrol STRAIGHT-THRU-FLOW regulator, where gases rush by with less turbulence than found in ordinary regulator designs. This straight simplicity is one of the secrets of top efficiency and less pressure drop.

You're missing a chance to cut manifold costs if you're not using STRAIGHT-THRU-FLOW. Capacities in excess of 6,000,000 btu/hr with nine AGA certified models available.

NO REGULATOR PERFORMS QUITE LIKE A MAXITROL

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Centralized heating, cooling planned

TAKING advantage of Cleveland's urban renewal project, a gas utility is planning an operational diversification that could be an important producer of new revenues for gas companies throughout the country.

The East Ohio Gas Co., Consolidated Natural Gas Co. subsidiary, is preparing preliminary plans for a large, self-contained heating and cooling plant for the city's downtown Erieview Urban Renewal Project.

The utility's plans call for a single plant, located somewhere in the Erieview area, which would supply heating and cooling for the buildings to be constructed in a 190-acre tract in the heart of the city.

In effect, East Ohio, instead of selling natural gas for heating and cooling, would be expanding its operation to selling heating and cooling itself.

Robert W. Ramsdell, East Ohio president, said that the company expects that the project will cost between $5 and $10 million, depending upon the size and number of buildings which will become part of Erieview. He pointed out, that in any event, the plant and all necessary piping would be so designed that it could be expanded to meet the needs of the future.

The Erieview plan, drawn by I. M. Pei, noted New York city planner, calls for the razing of all eyesore buildings and the construction of a shopping center, hotels, high-rise apartment houses, office towers and parks.

The city is condemning whole blocks for the projects, preparing for demolition. When the land is cleared, it will be sold to the highest bidder who pledges to construct the type of building called for by the plan on the site.

Ramsdell sees the East Ohio project as an added incentive to investors.

He points out that the single heating-cooling plant concept completely eliminates the need for each Erieview building to have separate heating and cooling facilities.

Besides doing away with the initial costs of purchasing and installing heating and cooling equipment, the single plant plan would

eliminate operating and maintenance costs for building owners. In addition, space that would ordinarily be used to house heating and cooling equipment would be available for rental.

A similar undertaking is already underway in Hartford, Conn., where the Hartford Gas Co. is building a $3 million plant to supply chilled water for cooling and steam for heat of a downtown urban renewal project similar to Erieview.

The Cleveland plant would be the second, and largest, in the nation.

Hartford Gas will supply summer cooling and winter heating to an area where three major office buildings, a shopping center, a 250-room hotel, a new broadcasting center and several multi-million dollar high-rise apartment buildings are planned.

According to Ramsdell, East Ohio would take advantage of proximity to an abundant supply of water which would be used in the cooling operation. Water from Lake Erie, immediately north of the Erieview area, would provide the system's condensing water, thus eliminating the need for the massive cooling towers which would be needed for such a large cooling operation.

A prototype of the cooling installation, where Lake Erie waters are used for condensing water in the cooling cycle, has been included in the construction of a $6 million apartment house project in Cleveland. The installation uses gas for heating and cooling.

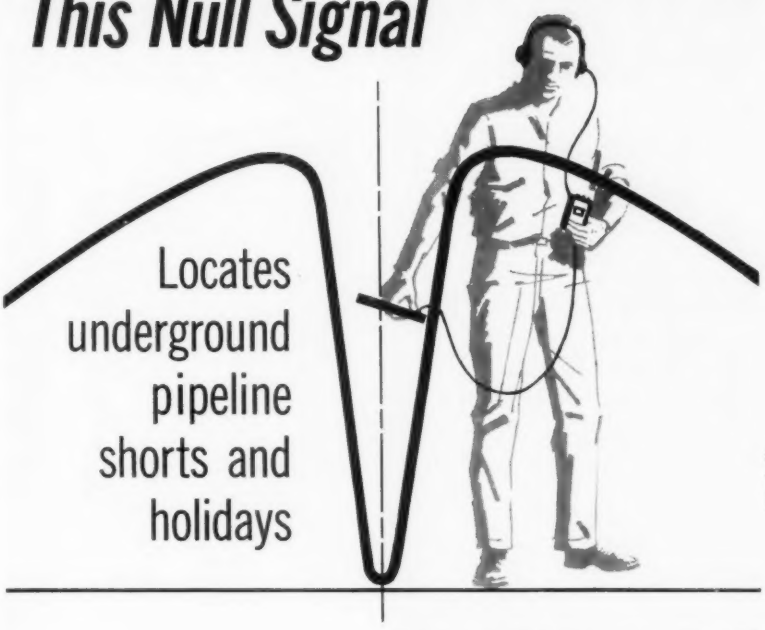
The East Ohio plant, styled architecturally to fit in with other Erieview buildings, would house offices, a dispatch center, control room and space for the gas-fired boilers and refrigeration equipment needed to supply chilled water and steam.

Two sets of pipelines, consisting of supply and return lines for chilled water and supply and return lines for hot water or steam, would loop their way through the area.

During cold weather, steam, generated by gas-fired boilers, would be piped to each building to provide heat. During warm weather, chilled water, produced by the highly effective absorption principle, would provide cooling.

The water would be chilled in huge absorption machines, activated by steam from the gas-fired boilers. Water piped to the absorption machines and then back to the lake would serve as condensing water.

This Null Signal



Locates underground pipeline shorts and holidays

The null search system, teamed with Tinker and Rasor all-transistorized, Pearson-type Detectors, has greatly simplified the location of electrical shorts and holidays in underground pipe coatings. Findings are made within inches because the null is a positive factor which is either present or not present.

The Tinker and Rasor Underground Detector employs a transistorized oscillator which generates a 15 watt, 750 cycle, stable A.C. audio-frequency signal. Two 750 cycle resonate filters in the receiver reject unwanted signals. Using a low impedance search coil, one man can inspect a buried line at a rapid walk. Shorts will be indicated sharply and surely. A two man team is equally effective in locating holidays.

Tinker and Rasor has prepared a complete data kit which describes the null search system as well as other recommended procedures for inspecting protective coatings. Material includes technical data on equipment, general discussion of types of detectors, theory of operation, etc.

Engineering Note:
To insure a perfect application, include Tinker & Rasor Holiday Inspection. Write for specification guide.

Quality Control for Coating Application

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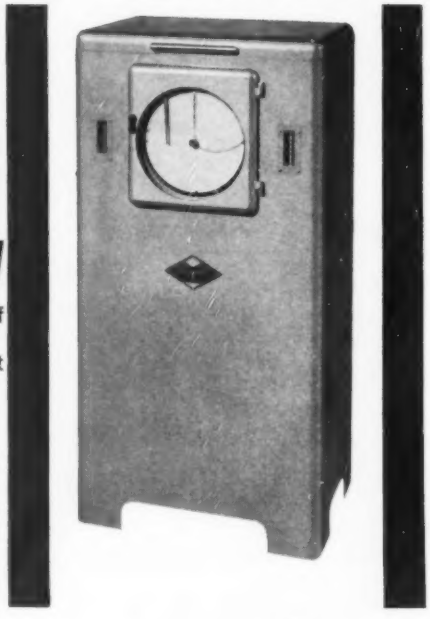

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W-I POW-R-DITCHER

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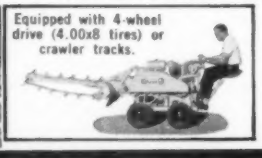
The new Model W-1 Pow-R-Ditcher is the "baby" of the expanding Vermeer Ditcher line. An ideal unit for contractors, utilities, custom operators and plumbers installing shallow service lines. The W-1 features all-hydraulic ground travel regardless of digging or transport speeds. The boom is also raised and lowered hydraulically. This is a powerful, rugged small trencher that "can really take it". Powered by a 9 hp. Wisconsin AENL engine. Gives maximum ground traction even under most rugged digging conditions. Ask for a demonstration.



PICK THE POW-R-DITCHER TO FIT YOUR NEEDS

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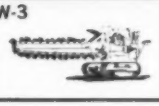

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Citizens Gas gives away cash in appliance push

Local appliance dealers and their sales personnel will get cash bonuses at the end of a four-appliance co-op advertising and merchandising program now being staged by Citizens Gas & Coke Utility of Indianapolis.

Basic idea behind the campaign is simply to get more Indianapolis dealers to do more gas appliance advertising, according to C. J. Taylor, supervisor of dealer relations for the utility.

Four almost identical promotions are running simultaneously to push Gold Star free-standing gas ranges, gas dryers, gas washer-dryer combinations, and gas incinerators. Although all four have similar rules and rewards, each promotion is separate, as far as advertising and awards go.

To qualify for bonuses in any of the promotions, a dealer must run an ad on the specific appliance in that promotion. The ad must: appear in one of the local papers, run during the campaign (April 15-June 30), measure at least 5½ in. x 8½ in., advertise only one type of appliance, mention the brand name of that appliance, and include a 2-in. x 4¾-in. AGA slug cut for that appliance.

If a qualifying dealer sells one or more qualified appliances, he will get $50 if his ad appeared in one of the big Indianapolis dailies, $20 if it was in another local paper. If he runs ads for all four types of appliances, he can get up to $200 in this fashion.

In addition there is a unit bonus. For each qualified range sold, for example, a dealer gets $10 and his salesperson gets $5. For incinerators, the dealer receives $7; the salesman, $3. And for both washer-dryer combos and dryers, the awards are $5 to the dealer and $2 to the individual.

Correction

In the article, "Short Aluminum Line Put to Bed" (March, pp. 138-142), a typographical error appeared in the price of aluminum. The price of unalloyed 99.50 per cent aluminum ingot is approximately $.26. In the article the price was quoted as about $.24 a pound.

New gas storage law sought in Michigan

A bill which would make it easier for corporations to condemn property for underground storage is sought in Michigan.

Under existing law, gas companies must acquire rights by negotiation for 90 per cent of property in a gas field area before they may resort to condemnation proceedings for the remaining 10 per cent.

The proposed legislation would require the companies to negotiate for only 75 per cent of the property rights before starting condemnation proceedings.

GAS • News Notes

Aspen, Colo., is negotiating with Rocky Mountain Natural Gas Inc., Denver, for a natural gas franchise to serve the ski center. Aspen's action followed that of Glenwood Springs in authorizing franchise negotiations with Rocky Mountain. The Denver-based firm thus has moved to serve all of the Roaring Fork Valley in western Colorado.

Southwestern Plastic Pipe Co., Mineral Wells, Texas, has purchased all the common stock of Ken-Way Plastic Products Corp., Phoenix, Ariz.

First shipments of plastic-coated pipe from Standard Pipeprotection's new Alton, Ill., plant will be made this month. The Alton plant, erected and equipped exclusively for the X-Tru-Coat process, initially will handle pipe up to 4 in. in diameter. It may be expanded for larger pipe in the future.

Plicoflex Inc., Houston, has absorbed the H & H Sales & Engineering Corp., also of Houston. The H & H organization, with offices in Houston, New York, Kansas City, Dallas, and Harvey, La., will become the sales division of Plicoflex. Tom Hajecate, sales manager of H & H, is now sales manager of the Plicoflex pipe wrap division.

Grove Valve & Regulator Co. will build a new manufacturing plant in Mexico soon. Located near Mexico City, the plant will be operated by Grove de Mexico, S.A., subsidiary of the Oakland, Calif. company.

install Lancaster meter parts for proven quality and performance

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VALVE COVERS
Engineered to prevent most common valve problems. Oversize stud provides friction-free contact with index drive flag. Micro-finish lapped surface assures perfect seal. Extra heavy valve shell covers top and sides of carbon-graphite ring for full protection.
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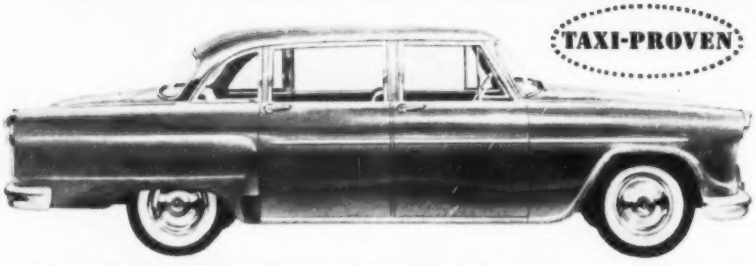

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GAS convention coverage

Research & utilization

OVER and above the many technical papers presented at the American Gas Association's Research & Utilization Conference in Cleveland in April, the theme set by the speakers seemed to be researching research. This at least was apparent in the keynoting speeches presented by L. T. Potter, president of Lone Star Gas Co. and AGA, and E. B. McConnell, senior vice president of The Standard Oil Co. of Ohio.

Potter, who called "Research — Our New Clarion Call," told more than 650 conference attendees that there is no activity in the gas industry that now receives more support, enthusiasm, and unanimous agreement than research. The clarion call, he stated, needs and will receive an answer.

"To do this," he continued, "we need particularly to have more research planning. I want to urge that we reach out in our planning and thinking to determine where we think we are going and where we want to go." Such planning and thinking, he added, comes from the active culmination of management and scientific endeavor in individual companies. "We (the individual companies)," he declared, "have got to do our 'homework' in research."

Continuing to research research, McConnell asked the group the following day, "Is industrial management looking at research in the right way?" He cited the example of a recent *Time* magazine survey of the 15 top scientists in the country. Only one of these, he noted, was from industry. The rest were from the fields of government and education.

McConnell then posed another very interesting question. "If you could hire an Edison or an Einstein," he asked, "which would you choose?" He used this as an example of the kind of decisions management must make regarding research programs. If the choice is an Edison, he warned, "It may be very difficult to mount a modern research program . . . (as such a

program may be) geared to the wrong generation. This short-sighted approach will, in the long run, result in the company's finding itself hopelessly out of date."

Later, McConnell supported in essence a plea made by the editor of GAS (see Thermally Thinking, GAS, Jan. '61) when he urged publication of their findings by the scientists and the researchers. This, he said, leads to "feedbacks from their peers in the business which keeps them from going haywire."

The 15 technical papers presented during the three-day convention were of high interest to the engineers present as was witnessed by the solid attendance at those sessions. Those papers probably generating the most interest were: Natural Gas Fuel Cells for Power Generation in Dwellings; Recent Advances in Thermionic Conversion and Their Application to the Gas Industry; and Thermoelectricity—Utilization by the Gas Industry. (Abstracts of several of these papers appear elsewhere in this issue.)

Another presentation which was enthusiastically received and highly controversial in the corridors later was, "The Consumer's Viewpoint on Gas Appliances." Elizabeth Sweeny Herbert, household equipment editor for *McCall's*, spoke on this subject. It was her contention that appliance manufacturers are, in some cases, missing such a viewpoint in their designs. A suggested remedy to this situation was given to GAS Magazine by C. S. Stackpole, managing director of AGA, when he urged that all the appliance manufacturers employ home service-type women to aid them in their planning and designing.

The conference concluded with a tour of the AGA Laboratories.

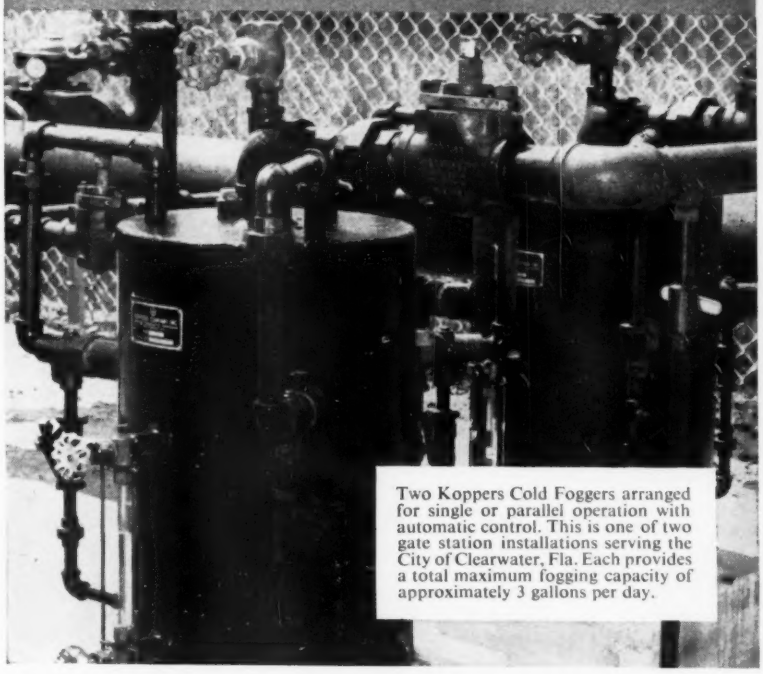
William T. Harper

Public affairs

AT a meeting of the Texas Oil Information Committee Public Affairs Conference (Corpus Christi, April 21), 350 people gathered to hear speakers discuss factors relating to the oil and gas industries.

Of particular interest to those in the gas industry should be the remarks made by Eugene Hosford, Gulf Oil Corp. and chairman of OIC. Hosford stressed that more time and attention should be given by industry personnel to public affairs and that not only interest

OIL FOG



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By introducing a fine oil fog into gas mains, Koppers Oil Foggers reduce maintenance of meters and regulators, condition main joints, minimize leakage, control dust problems and reduce service calls.

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W-250	Rated cap. 250cfh — FOB Philadelphia
W-300	Rated cap. 300cfh — FOB Philadelphia
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*propane

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Convention coverage

was required, but action predicated on study of the situation.

Hosford presented a plan that OIC suggests be followed by each company, in accordance with its own needs:

(1) Put someone in charge of public affairs.

(2) Build a first-aid kit of public affairs. This would be a collection of pertinent material to assist in taking part in public affairs and may include:

- Directory of state legislature
- Directory of key legislative issues
- List of sources of additional information
- Calendar of important political dates
- List of names of persons within company to whom one can turn for policy matters
- Instructions for writing letters to public officials

(3) Take a poll and start a program for better teaching of employees.

(4) Monitor what is being said; review newspapers' treatment of news and keep abreast of developments.

(5) Have a D-Day plan. In case of necessity for advising Congressman of sentiments on key issues, be prepared and know facts.

(6) Be aware of management policy.

The aims of The Texas Oil Information Committee is a better informed public aware of the operations and objectives of the petroleum industry.

(Similar treatment with respect to the gas industry may be of value in advising the public of the gas industry—its aims, objectives, and hardships.)

Ken Kridner

Gas measurement

KIRBY E. CRENSHAW, president of Cities Service Gas Co., delivered the principal address to 865 people attending the 36th meeting of the Southwestern Gas Measurement Short Course in Norman, Okla. Opening on April 18 and extending through April 20, the short course attracted attendants from 37 states, Mexico, and Canada.

Crenshaw spoke on the "Future

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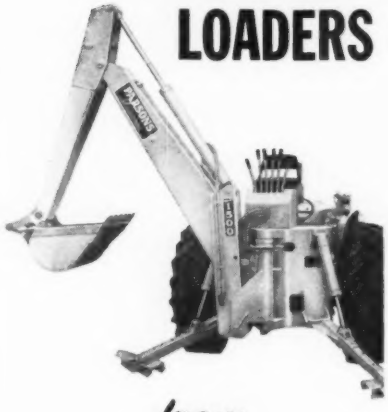

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S104-Gas

of the Gas Industry" and throughout his talk emphasized the possible growth of the industry. He pointed out:

Our industry: "Today the gas industry is a big industry. In terms of total assets, it is now the fifth largest industry in the United States. To serve their 33 million customers, the gas pipeline and distributing companies, at the end of 1960, had a gross plant account of nearly $22 billion."

Our gas supply: "The joint AGA-API Committee on Natural Gas Reserves reports that total proved reserves of natural gas as of Dec. 31, 1960, were 263.7 trillion cu ft. Our production during 1960 was 13 trillion cu ft. Based on these figures, we find that the ratio of known reserves to annual production is 20.3. . . . The Bureau of Mines, I am told, places our total natural gas reserves estimate—both present and future—at about 1000 trillion cu ft."

Effect of automation: "The advantages of automation have already been proven, and my crystal ball tells me that within a short while even the most timid of us will be giving consideration to the conversion of existing facilities, regardless of age or design, to automatic control."

On research: "Through research, our industry will continue to upgrade gas appliances and the utilization of gas at all levels of consumption, but particularly at the level of the residential consumer. . . . It is most important that our industry do everything possible to build up summer-time residential and commercial loads through the promotion of gas for air conditioning. . . ."

R. B. Fleske, Cities Service Gas Co., was chairman of the general committee for the 1961 short course and presided over the meeting. He pointed out that the attendance for the 1961 meeting exceeded that of last year and the 34 exhibitors displaying their products was an increase over 1960. There were 91 classroom sessions, presided over by members of industry, by faculty representatives of the University of Oklahoma, by a representative of New Mexico's Corporation Commission, by a representative of a research organization, and by representatives of manufacturers.

The 1962 edition of the Southwestern course will be headed by D. H. Lindsey, Northern Natural Gas Co.

Improved **PLASTOMET TRANSITION FITTINGS** offer a superior, uncomplicated, and safe method of joining plastic pipe to steel mains. These specially designed fittings make it possible to connect plastic piping to metal main lines, and to run metal pipe from plastic pipe for meter installations and other above ground connections. **PLASTOMET** fittings may be joined to the metal pipe end by either welded, compression, or threaded installation. Connection of the fitting to plastic pipe is made gas-tight by means of a solvent weld. Specially compounded "O" rings establish a gas-tight seal. Fittings are completely preassembled and may be used with all pressures presently found in gas distribution services.

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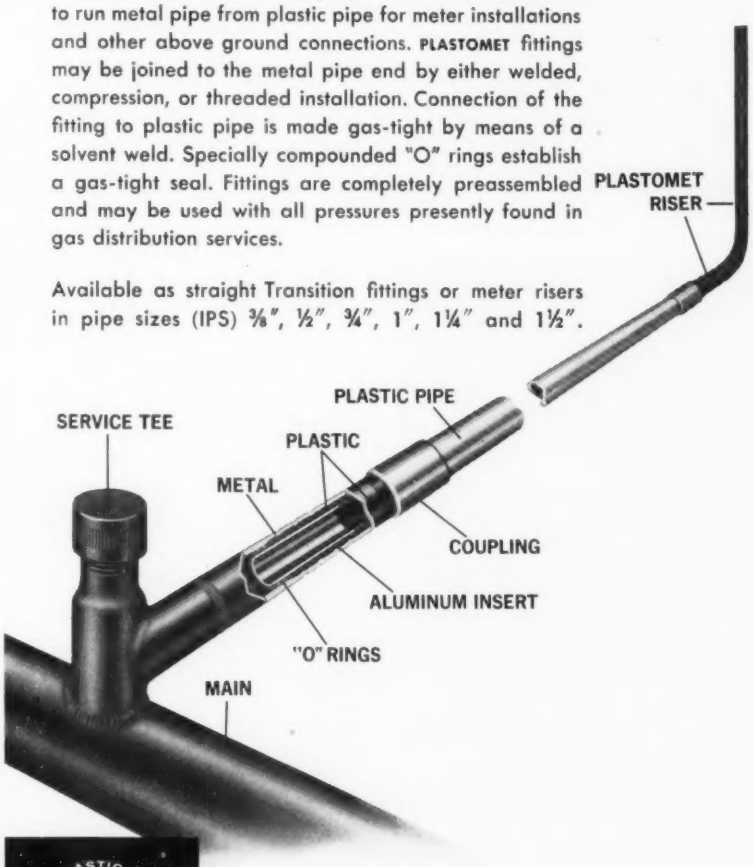

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FEATURING TORQUE TRANSMISSION DIRECT FROM GEAR SPIDER TO DRUM . . . NO KEYS TO SHEAR

20,000 pounds safe hoisting capacity

Outstanding features of the NEW KOENIG WINCH:

★ Drum torque load is NOT transmitted by drum shaft . . . no keys to shear . . . torque is transmitted direct from gear spider to drum by means of multiple-splined collar in gear housing.
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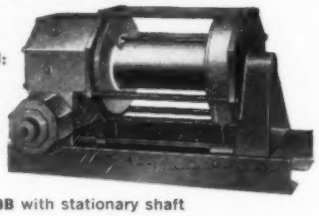
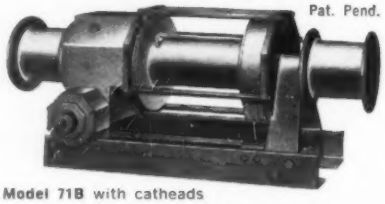


Model 70B with stationary shaft

Pat. Pend.



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Convention coverage

GAES

The seventh annual Gas Appliance Engineers Society Meeting was held in Cleveland prior to the opening of the American Gas Association's Research & Utilization Conference. The meeting was divided into afternoon and evening sessions. One of the highlights of the former was the announcement of the slate of officers for the forthcoming year. The new officers are: William Myler, Jr., Janitrol Heating & Air Conditioning Co., president; Jesse Reznor, Reznor Manufacturing Co., vice president; Walter Lee, Major Controls Co., treasurer; A. F. Craver, Patrol Valve Co., secretary.

Another feature of the first session was a presentation made by Guy Corfield, utilization engineer, Southern California Gas Co., and Gas Magazine's technical editor. Corfield, using a series of highly interesting slides, told how "The Future Belongs to Gas," a message he said that has been told a thousand times and yet can always be told again and again.

C. S. Stackpole, managing director of AGA, was the guest speaker at the evening session and he told the group, "Without Flame, It's Not the Same." Taking his cue from the association's R&U Conference, he said, "The gas industry is not a bit better than its research."

Urging that more attention be devoted to research, Stackpole pointed out that there are 17 chemical companies in this country which each devote 4 per cent of their gross income to research. "If the gas industry did this," he continued, "it would be putting $200 million into research per year and think how much further our industry could go if we did."

William Harper

PIEA-PESA

NEARLY 1000 persons representing membership of the Petroleum Industry Electrical Association and of the Petroleum Electric Supply Association gathered in Galveston, Texas, in April for the 33rd annual conference and exhibit of the two groups. Attendance of 386 members from the Industry Association

and 610 members of the Supply Association insured the success of the conference.

There were 159 booths wherein advances in the communications and automation fields were presented—an increase of 23 exhibitors over the 32nd conference.

Welcoming address was given by Charles Smith, president of the Galveston Chamber of Commerce. The opening address from the industry was made by Edgar U. Cochrane, vice president of Tennessee Gas Pipe Line Co.

Exhibitors included companies actively engaged in design and installation of communications facilities, power units and automatic control systems for the gas and petroleum industries.

A panel discussion on the subject of automation was presided over by Harold Riggins of Richfield Oil Corp., assisted by Ivan Cook of Sinclair Pipe Line Co. Aspects of pipeline control, voice communications, data transmission and computers were very ably presented by industry and manufacturing personnel. W. M. Osborne, Shell Oil Co., reviewed the industry requirements for an automated facility.
also, gas is frequently available as

Another panel discussion of interest to persons in the gas industry was on the economics of electrical drives for pipeline booster stations, with Mack Duncan presiding. Participating in the panel were Frank P. Gertson, Texas Eastern Transmission Corp.; Harvey Cherry Jr., Houston Lighting & Power Co.; and J. K. Howell, Westinghouse Corp. This session included a discussion of the facilities installed on Texas Eastern's system and a review of power cost and plant investment for electric drive stations.

Ken Kridner

Oil and gas power

PIPELINE engineers among the 470 registered for the 1961 Oil & Gas Power Division meeting of ASME (New Orleans, April 9-13), found 10 of the 14 technical papers presented of close interest.

At Monday morning's session, Erik Kelgard, master mechanic, Trans Mountain Oil Pipeline Co., highlighted his company's experience with dual-fuel engines.

On gas lines, he stated, internal combustion engines are almost without exception spark-ignited, gas-fueled. For liquid pipelines, also, gas is frequently available as

NEW BARTON 273 PNEUMATIC TRANSMITTER MEETS MORE APPLICATION REQUIREMENTS THAN ANY OTHER TRANSMITTER

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SERVICE LINES
Low, Medium and High Pressure

METER SETTINGS
Flat Head • With or Less Check
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INDUSTRIAL USE
Three-Way • Graduated Dial

APPLIANCES and EQUIPMENT
Lever Handle • Square Head
Flat Head
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fuel at an attractive price; but it is generally considered advisable to have engines capable of operating on an alternate fuel and able to switch immediately from one to the other.

With the development of the exhaust-gas-driven turbocharger as a means of increasing cylinder air charge and thus higher horsepower capability, the problem of maintaining fuel-air ratios for best efficiency with dual-fuel engines has become more complex. This is particularly true where very high charging pressures and high BMEP are involved. Trans Mountain has 16 engines arranged for dual-fuel operation, all connected to centrifugal pumps.

To obtain best fuel economy with dual-fuel engines, provision must be made to provide that, when the engine is operated as a gas diesel, combustion air quantity is reduced to about 75 per cent that required when the unit is running as an oil diesel. Changes in ambient temperature affect fuel economy and efficiency. In pipeline service, where throughput characteristics dictate the use of a variable-load, variable-speed engine, changes in pilot fuel timing and quantity as a result of speed changes also affect economy. Through control of these variables it is possible to effect fuel savings up to as high as 20 per cent.

One of the engines, experimentally fitted with guide vanes in the turbocharger, externally adjustable, permits holding the differential head between inlet and exhaust manifolds practically stable whether operating on gas or as an oil diesel. Scavenging rates therefore remain the same.

Since it can be demonstrated that good fuel economy generally results in reduced maintenance costs, there is an opportunity for greater savings than solely from the reduction of fuel used. Automatic controls are required if test results on a continuing basis are to be obtained. Lacking these, an orifice plate and manometer in the gas supply run offer valuable aid in obtaining the best adjustments.

Arthur S. Herman Jr., manager, Special Products, Koppers Co., Inc., discussed torsional vibration in the design and operation of internal-combustion engine drives and in installations involving reciprocating equipment. The design of a resilient coupling, utilizing compressed, resilient members between blades of the inner and outer sec-

(*Continued on page* 152)

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permanent
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simplifies assembly

- Insulation covers pilot flange and extends up the body—minimizes possibility of short circuits caused by moisture. No loose parts.
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Ask your American representative for Bulletin 308 describing all insulated and standard meter connections.

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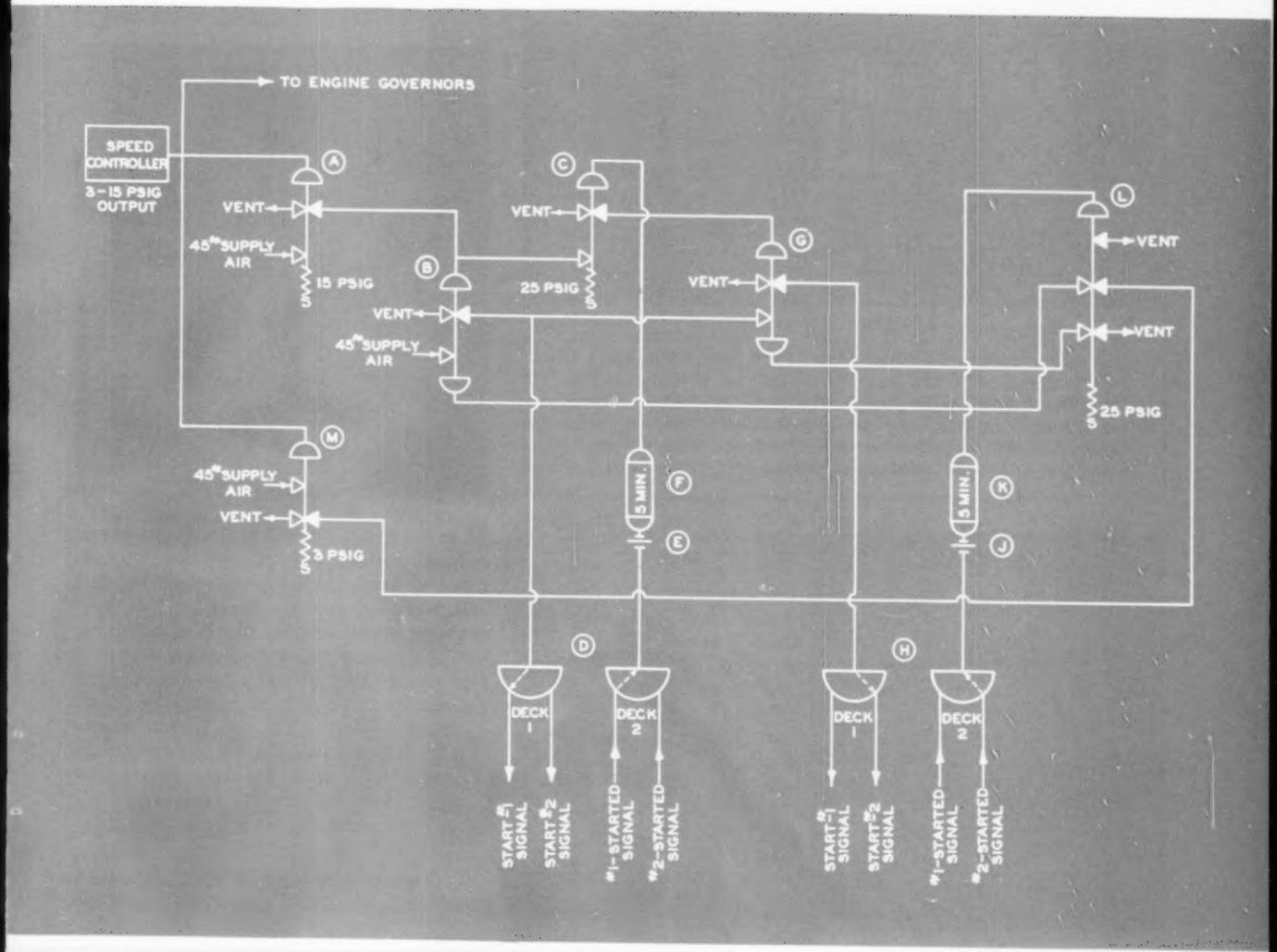
INCORPORATED ESTABLISHED 1836

Executive Offices: Philadelphia 16, Pa.
Sales offices in principal cities.

GAS

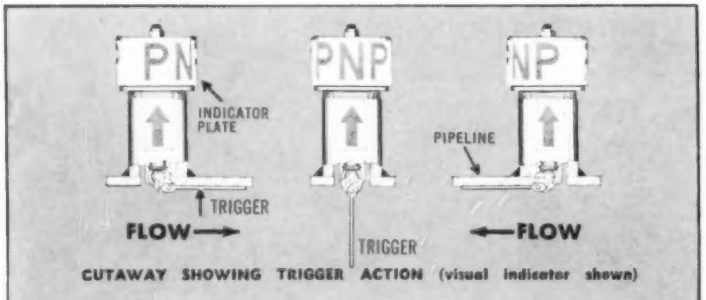
PIPELINE SECTION



Engines without pushbuttons

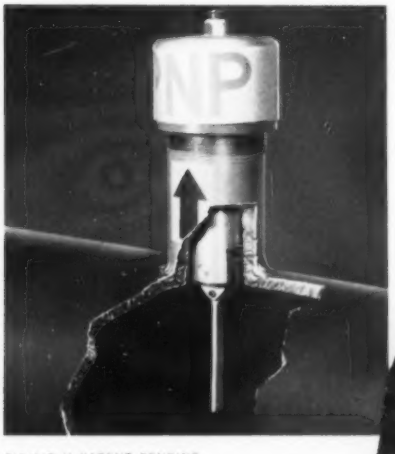
NEWS FROM DOWN THE LINE!

Successful PIG-SIG II
now has NEW BI-DIRECTIONAL TRIGGER
Plus Other Optional Features



CUTAWAY SHOWING TRIGGER ACTION (visual indicator shown)

• The WmSon PIG-SIG II Scraper Passage Indicator which has earned such wide acceptance in the pipeline industry is now available with bi-directional trigger as an optional feature. The trigger is designed for use in lines where scraper travel may be in either direction and in meter proving loops. Other optional features: pneumatic control with automatic reset and automatic counter to record scraper passage.



Long trigger action detects scrapers even in oversize pipe

In the top example, PIG-SIG II with visual indicator shows the station operator the pig has arrived. He doesn't need to wait and listen at the scraper trap. The next example shows how PIG-SIG II with electric indicator can signal arrival of pig to pump station operator. It can start operation of automatic equipment to open and close valves. PIG-SIG II is easily installed under pressure with WmSon-Hillco Tapping Machines. It is available with visual indicator and manual reset; electrical or pneumatic signal with automatic reset; extended or regular.

WRITE DEPT. C FOR BULLETIN A-199-A

PIG-SIG II PATENT PENDING

T. D. Williamson, Inc.

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REPRESENTATIVES AROUND THE WORLD

PIG-SIG II can be used to actuate pneumatic and electric control systems. WmSon engineers may be able to offer dollar saving tips on its use in such systems. **Contact your representative or the Tulsa office.**

Engines without pushbuttons

By BLAND OSBORN, Senior Project Engineer
United Fuel Gas Co., Charleston, W. Va.

ON the West Virginia bank of the Big Sandy river a subsidiary of the Columbia Gas System is using a fully pneumatic control system to operate four completely automatic, 1100-hp Ingersoll-Rand gas compressor units.

The units were installed at United Fuel Gas Co.'s giant Kenova compressor station in 1959-60 as one step in a far-reaching plan for expansion and modernization of the entire plant. Engineering studies indicated that certain functions performed by the station could be handled more smoothly and accurately by automatic equipment than by manual controls. It was this consideration and not merely a desire to reduce manpower requirements that led to the decision to automate part of the station. This judgment has been fully confirmed by a comparison of pressure charts obtained while operating the new I-R engines manually with those obtained after the controls were completed.

As inferred, however, the station is not unattended. One man is always present in the building which houses the four automatic units and four semi-automatic Cooper-Bessemer 2000-hp GMWA engines. His time is largely spent observing and reporting the pressures and flows indicated on the main station panel and dispatching gas through runs controlled from the panel to areas of western West Virginia and nearby Kentucky and Ohio. A second operator comes and goes, attending to scrubbers, drips, station auxiliaries, engine rounds, cleaning and light maintenance; but his duties involving the automatic engines are minimal and consist largely of logging information for maintenance records.

STATION OPERATION

The rather complicated operations at Kenova station, which grew like Topsy during the years following World War I, can be broken into two basic phases. In the first phase the four C-B GMWA's, in combination with four horizontal engines dating back to the 1920's, form a 12,600-hp complex which pumps rich Appalachian gas to the $7 million hydrocarbon extraction plant UFG built on an adjacent tract of land in 1958.

Gas leaving this extraction plant supplies customers in many areas, including Cincinnati, Ohio, and Ashland, Ky. Depending on the season and the time of day, these markets may take the full 160 MMscfd flowing from the plant or they may require as little as 75 MMscfd. Thus from 0 to 85 MMscfd surplus may exist downstream of the extraction plant, and it is highly desirable from an operational standpoint to remove the surplus gas accurately so that the flow through the plant can remain constant.

This exacting second phase is performed by the automatic I-R units, and the gas they take from the plant outlet is started on its way toward Columbia's eastern Seaboard markets. The pressure at the extraction plant outlet reflects the market demand, with the pressure rising as the demand decreases. Suction pressure is therefore the controlled variable. *Fig. 1* shows the eight steps used in the I-R control system to cover the required 0-85 MMscfd band. It will be noticed that the steps overlap to prevent unnecessary starting and stopping of engines when the pressure fluctuates about a particular point.

MAIN UNITS AND PIPING

The automatic units are I-R 10-cylinder, four-cycle, Model 410-KVG naturally aspirated engines rated 1100 hp at 330 rpm. The four compressor cylinders on each unit were selected to operate without the necessity of unloading over a suction range of 275-325 psig, and a discharge range of 600-700 psig. Each cylinder, however, is equipped with one large, air-operated pocket on each end. Because suction pressure is controlled and the units discharge into a large, year-round transmission system, it is not likely that control

of the unloaders for reasons other than capacity will ever be necessary. However, each unloader can be isolated from the automatic system and operated manually. To all intents and purposes, opening the two pockets on a cylinder completely unloads it, and this is the method used when running one engine half or three-quarters loaded as shown in *Fig. 1*. During starting, however, a bypass is opened to ease the load on the two I-R air motors which roll the engine through a ring-gear on the flywheel. This method of starting, while requiring somewhat more air than other methods, has proved highly satisfactory, with a minimum of maintenance and, of course, no difficulties with burned out starting air valves or engine "dead spots."

Each fully unitized engine discharges over its own fin-tube gas cooler section and through a Daniel piston check valve, which allows the manually operated suction and discharge valves to be left open unless work is being done on the engine. The gas cooler section and sections for lube-oil cooling water and engine jacket water are mounted on a tower over a 14-ft fixed-pitch fan. The fan is driven through a right-angle speed reducer and a horizontal shaft by vee belts on the engine flywheel. Mounted below the compressor building floor and interposed between the vee-drive and the horizontal shaft is an American Blower VS-126 fluid coupling. The output speed of the coupling is controlled by engine jacket water temperature through a Minneapolis-Honeywell Air-O-Line-Grad-U-Motor combination. Amot thermostatic valves are used for oil temperature control and as a fast warm-up bypass on the jacket water, and both water systems are protected by glycol-base antifreeze.

The crankcase oil level is maintained by a Ren controller with oil from the station's elevated storage tanks, and the lubricator levels are also maintained by float controls with oil from the engine pressure system.

One I-R unit, called the "switch engine," has larger cylinders than its sister units, and is piped so that it can be used, less its automatic features, in conjunction with the four 2000-hp GMWA-8's. These latter are also fully unitized and pneumatically protected and controlled, but have pushbutton starting and loading, and manual speed set point.

Compressed air for the entire station is furnished by two 50-hp Gardner-Denver RTC two-stage compressors equipped with aluminum pistons and teflon rings and packing. These units need no cylinder lubrication whatsoever, and air from them is used, after drying, both for engine starting and for the control system.

CONTROL DESIGN

The entire 12,400-hp, 1959 installation at Kenova, including the control system, was designed by Gulf Interstate Co., Houston, and 95 per cent of the control devices were manufactured by Westinghouse Air Brake Co. All the directional relays are Westinghouse Type D Pilotair valves in one of their many forms. These are a sliding spool, two to five port valve and are available with a variety of operators on one or both ends. All the snap-acting relays are WABCO Relayair valves, the manual selectors are Rotair valves, and WABCO shuttle valves, quick-release valves, and shutdown devices for both temperature and pressure were also utilized.

To achieve the precise, reliable and consistent Kenova system, Gulf Interstate followed these basic control concepts:

(1) No attempt was made to miniaturize. All the pneumatic tubing is $\frac{3}{8}$-in. OD copper with flare fittings, the snap-acting valves weigh 6.5 lb each, and all orifices and timing tanks are large. For example, two-minute timing tanks were made of 30-in. long pieces of $8\frac{5}{8}$-in OD pipe. This principle resulted in a physically strong system with components that are relatively unaffected by foreign particles, corrosion, age, or temperature.

(2) The use of low pressure air was avoided. Certain controllers and the valves and positioners which they directly operate are limited to the conventional 3-15 psi, but at the first relay available, the pressures are raised to 45 or 125 psig, and all subsequent timing, sequencing and power operations are carried on at these pressures. This method provided all the components with plenty of power to perform transfer operations, made leak inspection easier, and helped preclude failures due to sticky O-rings, stiff diaphragms, lack of lubrication, differential expansion binding, etc.

(3) External adjustments were eliminated. This philosophy placed a heavy burden on the engineers and manufacturers, and resulted in a few components which required modification after startup, but it all proved worth the effort at Kenova. All orifice sizes are fixed, and all snap-acting valves are factory set. With the exception of the air supply regulator adjustments there is no way short of a repiping job to bypass, eliminate or modify the system's operation. There are, of course, emergency controls available which allow manual engine starting and control.

ENGINE CONTROL

Each engine control panel is a conventional enclosure with a rectangular vertical face. On the face are valve handles which can be used to start the engine and control its speed manually, and also the usual instruments and gauges. These include a manometer used both to check the vacuum between the air filters and the engine and the pressure in the crankcase, a fuel pressure manometer, a jacket water temperature recording controller, and Bailey Mini-Line indicators for left and right hand manifold vacuums, oil pressure and oil temperature, starting air pressure, and engine speed. Also included is the only electrical instrument in the system, an indicating exhaust pyrometer with a manual scanning switch. At the top of the panel is a row of visual annunciators, one for each of the engine shutdown conditions and one for the condition of low crankcase oil level, which sounds an alarm but does not stop the engine. The annunciators are not relays in themselves, and they operate on an independent air system so that an annunciator failure does not affect engine operation.

The control system itself is basically a "series" one,

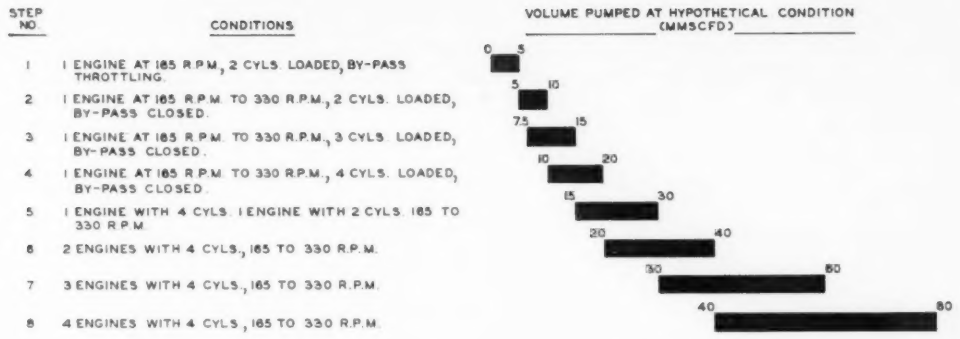

STEP NO.
CONDITIONS
VOLUME PUMPED AT HYPOTHETICAL CONDITION (MMSCFD)
1 1 ENGINE AT 165 R.P.M., 2 CYLS. LOADED, BY-PASS THROTTLING.
2 1 ENGINE AT 165 R.P.M. TO 330 R.P.M., 2 CYLS. LOADED, BY-PASS CLOSED.
3 1 ENGINE AT 165 R.P.M. TO 330 R.P.M., 3 CYLS. LOADED, BY-PASS CLOSED.
4 1 ENGINE AT 165 R.P.M. TO 330 R.P.M., 4 CYLS. LOADED, BY-PASS CLOSED.
5 1 ENGINE WITH 4 CYLS. 1 ENGINE WITH 2 CYLS. 165 TO 330 R.P.M.
6 2 ENGINES WITH 4 CYLS., 165 TO 330 R.P.M.
7 3 ENGINES WITH 4 CYLS., 165 TO 330 R.P.M.
8 4 ENGINES WITH 4 CYLS., 165 TO 330 R.P.M.
0 5
5 10
7.5 15
10 20
15 30
20 40
30 60
40 80

Figure 1.

with a Foxboro speed transmitter as a heart. The transmitter's output varies from 3 to 15 psig corresponding to engine speeds of 0 to 360 rpm, and this signal is used to trigger starting steps. It provides a much more consistent and sensitive indication of engine speed than such substitutes as oil or water pressure, and is also used with a suitably calibrated gauge as a tachometer.

When a start impulse is received, either manually from the engine panel or automatically from the station control panel, the following steps take place: (a) a trace circuit checks the position of the suction, discharge, and bypass valves, and of the ignition grounding relay, and if these are satisfactory; (b) the prelube pumps on both the lubricators and the main oil header run for a period of one minute, the top of the pneumatic-set-point governor is vented, and the low lube oil pressure shutdown device is bypassed, after which; (c) the starting air comes on.

When the speed transmitter output reaches 5 psig, indicating that the engine is rolling 60 rpm, a snap-acting relay sends a signal through a 5-second delay tank to the piston operator on the ignition grounding relay. The delay allows purging of the cylinders and exhaust manifold. Although this is not as vital on four-cycle engines as on two-cycle, it seems well worth the minor expense involved. The ignition will now remain on until engine speed drops below 60 rpm, since all shutdown devices and sequences operate only the fuel gas valve. Operation of the ignition grounding relay causes the valve tracing circuit to transfer to tracing the following shutdown devices:

(1) High jacket water temperature
(2) High oil temperature
(3) High discharge gas temperature
(4) High discharge gas pressure
(5) Low engine oil pressure (bypass)
(6) Cooling fan vibration
(7) Engine vibration
(8) Station emergency shutdown
(9) Starting sequence fault
(10) Loading sequence fault

If all these are satisfactory the signal will pass through them and open the fuel valve. The engine should now fire, and when the speed transmitter output reaches 7.2 psig (125 rpm) a snap-acting relay performs the following steps: (a) turns off the starting air; (b) starts a 40-second low lube oil pressure bypass timer and a 10-minute engine warmup timer; (c) closes the governor vent and sends instead a 3-psig signal to bring the engine up to its 165 rpm idling speed; and (d) closes the engine bypass valve and locks out the prelube, starting air and starting sequence fault devices.

After the 10-minute warm-up period the speed set point line to the top of the engine governor is switched from the fixed 3-psig signal to the output of the station speed controller. All set point signals to the top of the governor pass through a Moore inverse derivative relay which acts as a 1:1 booster which temporarily widens its proportional band under high differentials. If a 15-psig "full-speed" signal is awaiting the engine when it is switched to station speed control the large difference between the 15 psig and the 3 psig already on the governor causes the relay to restrict its output "orifice," but as the differential becomes smaller the "orifice" becomes larger. This useful, compact instrument results in extremely smooth speed control under any conditions.

At the same time that the engine is switched to station speed control, it accepts whatever load signal awaits it from the station control panel. Load is applied one cylinder at a time at 10-second intervals, and when loading is complete a signal is sent to the station control panel, which then sets up the next engine for starting.

While all the above-mentioned starting steps are essentially in series, as the sequence starts an air signal begins along a parallel route, racing the starting sequence to predetermined points along the line. If the starting signal arrives at a point first, the fault signal is diverted along a timed path to the next point. If the fault signal arrives first, the starting sequence shuts down and a signal is sent to the appropriate annunciator, the alarm horn, and the station control panel. The station panel will then bypass this engine and start the next one. This same system is used if, after starting, the engine fails to load properly.

To stop the engine, the station control panel removes the start signal which causes the engine to drop back to 165 rpm, unload over a 40-second period, idle for three minutes, shutdown and afterlube for one minute, and then reset itself for another start.

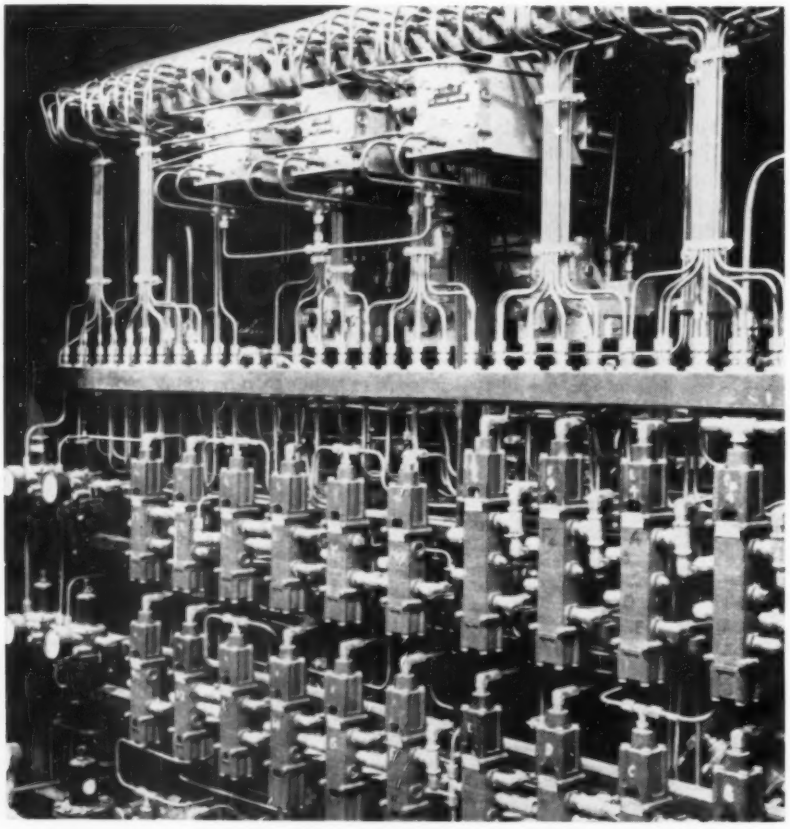
STATION CONTROL

The station control panel, like the engine panels, is of conventional rectangular design. Across the top of the face are visual annunciators showing which of the eight engines in the building are running, and the load condition on any engine running partly loaded. There are also annunciators for station-wide alarm conditions such as low instrument or starting air pressure, and boiler trouble. In the center of the panel are the three controllers that actually operate the station. These are flanked by circular-chart suction and discharge pressure recorders, one for the high pressure I-R system and the other for the lower pressure C-B system. In a row below the recorders are the engine operating sequence selectors with their bypass knobs above them. Finishing the rather simple array are the alarm silence and annunciator reset buttons. The panel and the station control system are both set up to operate five automatic engines, although only four are presently installed, and thus the bypass knob for the fifth position engine remains pulled at all times.

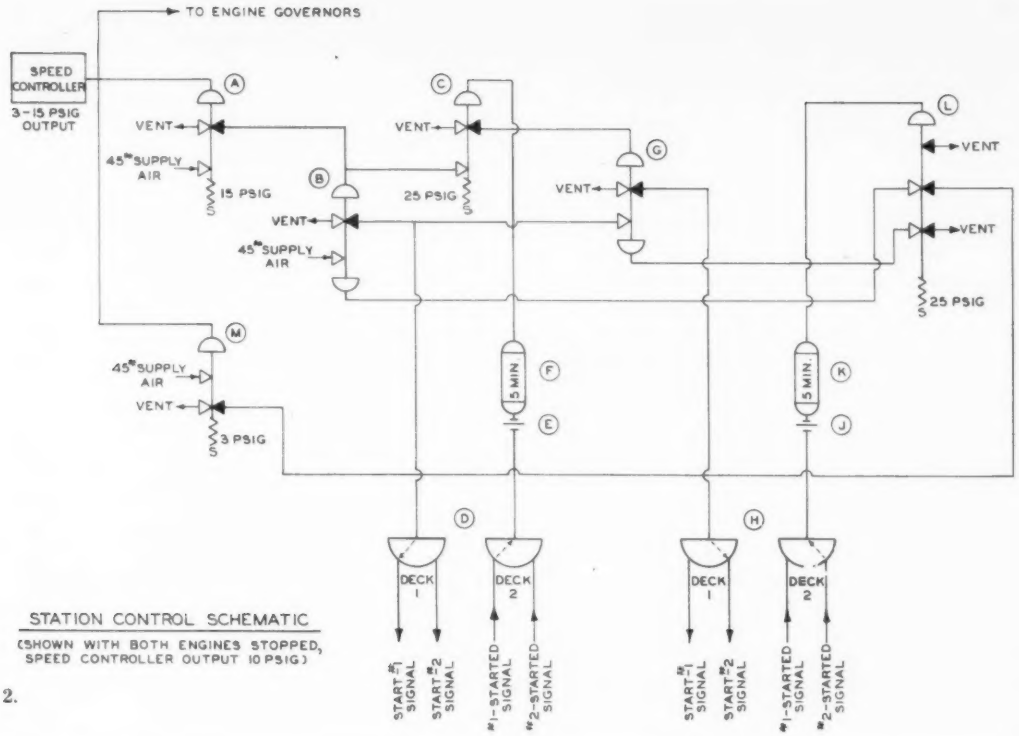
Under normal conditions, operators at the station need concern themselves with only five controls as far as the I-R units are concerned. All of these are mounted on the face of the station control panel. The setting of four selector valves determines the sequence in which the engines are to operate. The first engine to come on the line must be either Unit No. 1 or Unit No. 2 because only these two engines are presently equipped with the loading sequences necessary to operate with only two, or three, of the compressor cylinders loaded. After selection of the "first position" engine, the remaining three may be used in any desired order. The order may be changed at any time, whether the engines are running or not, although certain precautions are necessary when switching a "down" engine with a running one.

After the running order has been set, the only other control is the suction pressure set point knob. The set point is tied into three Minneapolis-Honeywell Tel-O-Set controllers. These three form the "brains" of the system, and all operate in conjunction with a M-H pressure transmitter on the suction header which puts out a 3-15 psig signal over a 275-325 psig suction pressure range.

The first controller, called the "bypass controller," has a narrow proportional band and an inverse output. It has only two functions. It initiates the start of the "first position" engine when its output drops to 3 psig, and it operates an air-to-open bypass between the suction header and the discharge header. This bypass valve operates only while the "first position" engine is running half loaded; that is, only during Step 1 as shown in *Fig. 1*. The bypass controller set point is permanently biased 5 psi below the set point of the other two controllers, and its entire output is blocked



Left: A portion of the instruments in the back of the station control panel.



STATION CONTROL SCHEMATIC

(SHOWN WITH BOTH ENGINES STOPPED, SPEED CONTROLLER OUTPUT 10 PSIG)

Figure 2.

when the other controllers take over operation of the station.

The second controller, called the "speed controller," has a somewhat broader proportional band, reset, and a direct output. It controls engine speeds, all starting steps except the first one, and all stopping operations except the last one.

Let us see, by example, how these two controllers operate. Assume that the suction set point is 300 psig. This is the set point of the speed controller, which has a proportional band from 295 psig to 305 psig. The bypass controller set point is 5 psi less, or 295 psig, and its proportional band is from 293 psig to 297 psig. Assume also that the suction pressure has been below 293 psig, but is rising as the day warms up and the consumer demand drops off. The bypass controller has been putting out its maximum signal of 15 psig, but this has not been reaching the bypass valve because no engine is running. As the suction pressure rises past 295 psig, the bypass controller's output will drop until it reaches 3 psig. At this pressure a snap-acting valve will operate, and start and half load the "first position" engine. The speed controller output is blocked during Step 1 (see *Fig. 1*), so this first engine will run at minimum speed. When the engine was loaded, the bypass controller signal was allowed to go to the bypass valve, and the valve will now throttle if the half-loaded engine pumps *too much* gas, and attempt to hold the suction pressure above 295 psig.

Assuming that the market keeps cutting back and the suction pressure continues to rise, the speed controller will take command of the station. This controller, as mentioned, has a proportional band between 295 psig and 305 psig, and is direct acting. As the suction pressure rises, the speed controller's signal will increase the speed on the "first position" engine, seeking to hold 300 psig. By this time, the bypass valve is completely closed because the bypass controller's output dropped to 3 psig at a suction pressure of 297 psig.

This arrangement means that over the suction band from 297 to 300 psig an engine is ready, warmed up, and capable of speed control and rapid loading of the remaining two cylinders. This prevents the station from being caught "flat-footed" by a rapid change in pressure. As more engines come on the line the spread of volume with speed control alone becomes very wide, and sudden fluctuations can be promptly handled with no difficulty.

If the suction pressure in the above example continues to rise, or remains above 300 psig, the reset action of the speed controller will raise its output to 15 psig. At this pressure, a snap-acting valve in the station panel will call for the next loading step, and this action will be repeated as many times as necessary, until all the engines are on and running at maximum speed. In essence, every time the speed controller output reaches 15 psig, a starting step occurs. After the step has been in operation five minutes, a timing-tank-snap-acting-valve combination opens a valve to the next step, and if speed controller output is still at 15 psig, or when it again reaches 15 psig, the next step will occur. If a loading step satisfies

the speed controller, its output will drop from 15 psig, of course, and the next loading step will not occur. Conversely, every time the speed controller slows all the engines down and reaches a 3 psig output another snap-acting valve operates and an unloading (or stopping) step occurs. There is also a five-minute delay between stopping steps.

The third controller, called the "upset controller," has the same set point as the speed controller, but has a proportional band from 293 psig to 307 psig, and rate action but no reset. Its sole function is to sense rapid changes in suction pressure, and if these are serious enough, bypass the 10-minute engine warm-up period. In normal operation, it requires 72 minutes to go from a station "down" condition to a fully "on and loaded" condition, but because the upset controller can cut out 40 minutes of warm-up time, it is possible to proceed through the entire sequence in 32 minutes.

CONTROL DIAGRAM

Fig. 2 is a much simplified portion of a two-engine control system, which will serve to show how the various components are used at Kenova. All the valves shown with triangular ports are transfer valves, but the ones shown with an "S" underneath are snap-acting at the pressure shown. The dome shaped symbols signify diaphragm or piston operators, and the zig-zag lines indicate spring returns on the valves. To follow the operation, it is only necessary to remember that air on a valve diaphragm pushes the black triangles on the RIGHT side downward (or away from the diaphragm end). Without air the springs will push the triangles on the right upward to the position shown, or if no spring is shown the triangle will remain in the position to which it was last pushed. Two selector valves are also shown, each with two "decks," and the routing through the decks shown by arrows.

If we assume that both engines are stopped, but that one is needed, the following steps will take place: when the speed controller output reaches 15 psig the diaphragm of Valve A will snap down, allowing 45 psig supply air to proceed to the top diaphragm of Valve B and to one port of Valve C where it is blocked. The pressure on the top of Valve B allows 45 psig supply air to travel through Deck No. 1 of selector Valve D to start the first engine, and 45 psig supply air also proceeds to one port of Valve G where it is blocked. After the first engine has started and is loaded, a feedback signal returns via Deck No. 2 of selector Valve D and bleeds through Orifice E and Timing Tank F for five minutes.

During this five minutes, assume that the starting of the first engine temporarily satisfies the speed controller and its output drops below 15 psig. This will cause the spring to snap Valve A back to its original position and vent the pressure on the top diaphragm of Valve B and also remove it from the lower port of Valve C. Valve B will remain in the same position, however, since there is no spring return nor any pressure on the lower diaphragm.

At the end of five minutes, the pressure in Timing Tank F has reached 25 psig and snap-acting Valve C operates. This has no effect on the system at present.

Now assume that the controller output again reaches 15 psig. Valve A again operates and passes air to the top of Valve B which has no effect, and also to the top diaphragm of Valve G through the now open Valve C. Operation of Valve G allows 45 psig supply air, which is available at the right side of Valve B, to proceed through Deck No. 1 of selector Valve H and start the second engine. When this engine is loaded, a feedback signal will return through Deck No. 2 of Valve H and via Orifice J and Timing Tank K, to the top of Valve L. Five minutes will pass before Valve L operates, and its operation will have no effect on the system

Assuming that the market demand now increases, the speed controller will gradually slow both engines down and its output will finally reach 3 psig. At this pressure, Valve M operates allowing 45 psig supply air to proceed through Valve L to the bottom diaphragm of Valve G. There can be no pressure on the top diaphragm of Valve G because this can only happen when the controller output is 15 psig, so Valve G operates venting the air which started the second position engine. This stops the engine, which in turn removes the feedback signal. In about four minutes the 45 psig air bleeds out of Tank K through Orifice J, and Valve L operates.

If stopping the second-position engine was not enough to satisfy the change in market demand, the speed controller output will remain at 3 psig, and Valve M will keep 45 psig air on the bottom diaphragm of Valve G via Valve L. However, when Valve L operates four minutes after the second-position engine stops, this air is transferred to the bottom diaphragm of Valve B. This vents the air to the right of Valve B, stopping the first-position engine. In four minutes the air bleeds out of Tank F, Valve C operates, and the system is ready to be started again.

THE FUTURE

The passengers on a recent flight from New York to San Francisco reportedly heard this announcement over the intercom system shortly after takeoff, "Ladies and gentlemen, congratulations. You are aboard the first completely automated passenger flight. There is no pilot at the controls. You have taken off under the guidance of a flight computer; you will be guided to San Francisco by a special radar network; you will land there automatically, and because human error has been completely eliminated, nothing can possibly go wrong . . . go wrong . . . go wrong . . . . " The writer does not wish to be placed in the position of the man who made that recording, but the perfect-circle pressure charts from the recorders at the compressor station will fully substantiate a prediction that nothing will "go wrong" at Kenova, and the knowledge gained from the installation, both in the engineering and operational phases, will be added to the fund of automation know-how available to Columbia's management as they contemplate an automatic future for the 146 compressor stations along their pipeline network. ■

automation in gas industry operations

PART III of a field study in depth: Public Service Co. of Colorado Northern Illinois Gas Co.

By KEN KRIDNER · Engineering Editor

IN this month's article, we will continue to look at applications of automation within activities of distribution companies. We have seen from reviewing operations of Southern California and Southern Counties Gas companies that their approach to automation has been limited to use of remote set-point and telemetering, although Southern Counties has installed compressor facilities capable of self-contained automatic control operation.

However, in these companies management is reviewing possible benefits to be achieved from use of automated facilities. Studies are now in progress to determine end-results that might be expected from adoption of the philosophies of automatic control.

Public Service Co. of Colorado

LOOKING across the Rockies to Denver, Colo. we can observe the activities of the Public Service Co. of Colorado. Public Service obtains its gas supply to serve the greater Denver area from Colorado Interstate Gas Co. and from Colorado Wyoming Gas Co.

Gas enters the facilities of Public Service through four metering points of Colorado Interstate and from a single point on the system of Colorado Wyoming. In addition to these sources of supply, Public Service is currently engaged in a project to utilize an abandoned coal mine for underground storage to augment supply for peak load conditions; however, this program is in the development stage and has not yet achieved final operational status. Thus, the Denver utility depends on gas holders located throughout its system and on suppliers' line pack to insure an adequate supply of gas during periods of peak-hour load within its distribution area populated by over 600,000 people. With the rapidly changing weather conditions experienced at the foot of the Rockies, Public Service must utilize all the skill and knowledge of its seasoned dispatchers to properly distribute gas through its interlaced distribution network when sudden weather drops are experienced.

Public Service also must control gas takes during peak day periods to preclude application of penalty provisions in its purchase contracts with suppliers. Previously, the distributor purchased gas from its suppliers under a rate schedule incorporating a billing demand charge. The rate for billing demand volume was considerably higher than the rate for resale gas. To exceed this billing demand volume during a peak day period resulted in an increased cost.

Public Service attempted to operate its facilities in such a manner that during peak day conditions it would not exceed the established billing demand volume while approaching as near as possible to it. This presented dispatchers with a crucial problem. They had to use sound judgment predicted on the best information available to predict the required deliveries for the day; curtailing interruptible customers only as necessary and then for the minimum time possible.

Public Service' solution approach has been two-fold. For many years the company had utilized a Bristol telemetering system at the purchase metering points, displaying the data on Bristol recorders in the dispatcher's office. PSCo. felt it would be beneficial to have computations of gas flow and summarizing of flow data performed by an electronic computer, freeing the dispatcher from a time consuming task. Working under the direction of Bruce McCannon, superintendent of gas supply, and chief dispatcher Ray

Silkensen, Bill Karcher and Bill Neahr undertook an investigation of hardware available. They desired to use the existing telemetering system where possible.

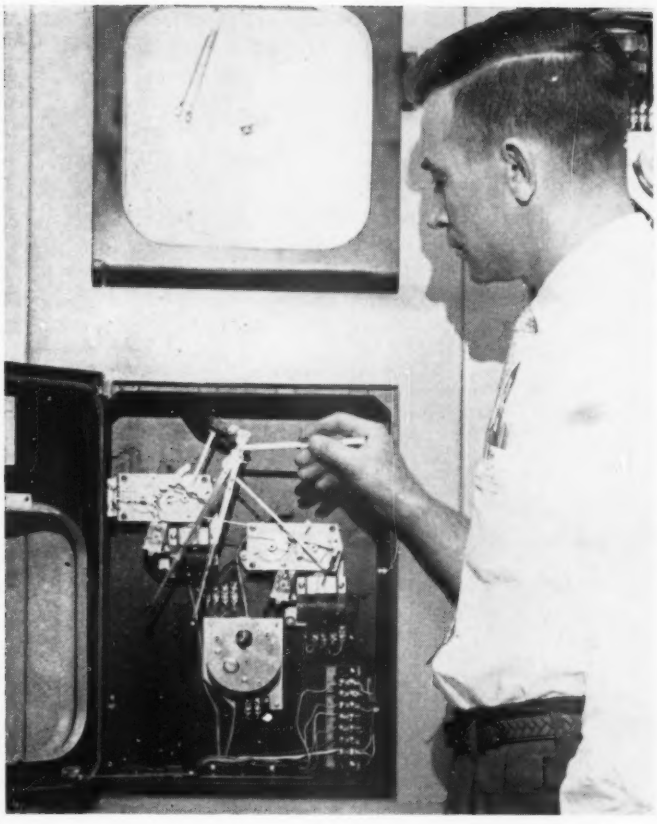
Their problem was two-fold: (1) to obtain computing equipment with which they could obtain gas flows, could tabulate total deliveries through each station and could print out information as desired by the dispatcher and, (2) to adapt existing data available at the Bristol recorder into a form compatible with the computing equipment.

After reviewing computers available on the market, Public Service selected a Libratrol 500 as being the most applicable for its particular service. The Libratrol 500 computer has a storage capacity of 4096 words. Data may be introduced through a typewriter input or through use of analogue voltage into the entry convertor. In order to convert existing data from the Bristol recorder into a form acceptable to the input logic of the computer, the technicians decided to couple a 0-to-10 volt potentiometer to the shaft of the Bristol recorder. As the shaft rotates, reflecting an increase or decrease in differential pressure, static pressure or temperature condition, the degree of rotation is transferred to the potentiometer through a series of linkages. The result is a voltage output that may be introduced into the input logic of the computer.

Data fed the computer on characteristics of gas flow may be processed in accordance with steps programmed into the computer. The volume of gas calculated for each meter tube is verified and then summarized for each meter station. In the event an erroneous value of data had been obtained, the computer through an internal checking program would discard the erroneous reading and use information from the preceding period. At the same time, the code number of the station transmitting the erroneous data, together with the type of data in error, would be printed out for action by the dispatcher.

Data enter the computer input in groups of eight. The input is capable of handling 80 values. Under the operation Public Service contemplated, 55 items of data would be brought in requiring only two minutes of on-line operations of the computer. The remaining four minutes of time would be used for off-line use of the computer. In the past, off-line time has been used for resolving engineering problems related to loop system analysis and for gas measurement calculations of meter charts.

Determination of on-line time is accomplished through internal programming whereby the computer interrogates itself periodically as to the amount of time expired. When the time has arrived for the computer to resume its on-line function of interrogating the recorders for measurement information, it would discontinue the off-line function and perform the dispatching operation. On-line operations are programmed to take precedence over other operations of the computer.



At Public Service of Colorado . . . Far left: W. J. Karcher, dispatching engineer, enters data into Libratrol 500 computer as chief dispatcher and measurement engineer Ray Silkensen (left) and dispatching engineer W. G. Neahr watch. In the left background is a portion of the Bristol recorders. To the center and right is the display equipment for Minneapolis-Honeywell supervisory control equipment for Public Service's remote compressor stations. On this page, senior dispatcher Forest Erickson points to the modification of the Bristol recorder adapted by Public Service to permit use of existing equipment with its electric computer. Linkage assembly enables the company to obtain a voltage output from 0 to 10 v for use with the computer and yet retain the current chart record.

Public Service of Colorado also has compressor station facilities located on its gas system on the western slope of the Rockies. These facilities consist of compressor stations located at Piceance Creek on its system connecting El Paso Natural Gas' pipe line system to the city of Rifle, Colo., and at Douglas Creek on its system between its producing field and Grand Junction, Colo. They desire to supervise operations of these stations from the Denver dispatching center. To accomplish this, they have installed Minneapolis Honeywell supervisory control hardware to control Clark reciprocating compressors. The equipment also telemeters data to the dispatch center.

There are two Clark compressor units installed at Piceance Creek. Utilizing a multipoint data logging instrument, Public Service brings data from the station into Denver reflecting static and differential pressures; flowing temperature of the gas upstream and downstream of the compressor station; station suction and discharge pressure; starting air pressure at the station; pressure at Rifle downstream of the station; the position of the by-pass valve; and speed indication of the number one and two compressor units.

When the dispatcher has noted from the data logger that the station is required and that all variables incident to the starting of number one unit have been satisfied, he can start number one engine by depressing the start button, activating the sequence start-stop unit at the station. After the station is running and on the line, the dispatcher can adjust speed as desired. Should number two engine be required, a similar procedure is followed. The engines may be started or stopped and speed adjusted from the dispatch center; however, remote start of Douglas Creek station is not possible under existing operations. The company recently revised the telemetering circuitry to improve the operations and reliability of its system.

Public Service also has three Worthington compressors for injection service at its underground storage project. Operations will necessitate an injection pressure of 175 psig. The operation of injection units will be controlled from suction pressure—when pressure drops below a preset point, the compressor will be automatically started, brought on the line, and loaded. Currently, control of the compressors is directed from supervisory equipment located in an auxiliary building adjacent to the compressor building. This equipment will be relocated in the future to provide for supervisory control from the dispatch center.

The Denver-based gas company's approach to the problems confronting it has evidenced its desire to obtain fullest utilization of abilities and knowledge of its personnel by assigning routine work to automatic control equipment. Utilization of a high speed computer will enable its dispatcher to have continuous surveillance of operating conditions and gas requirements permitting system operations on a very narrow

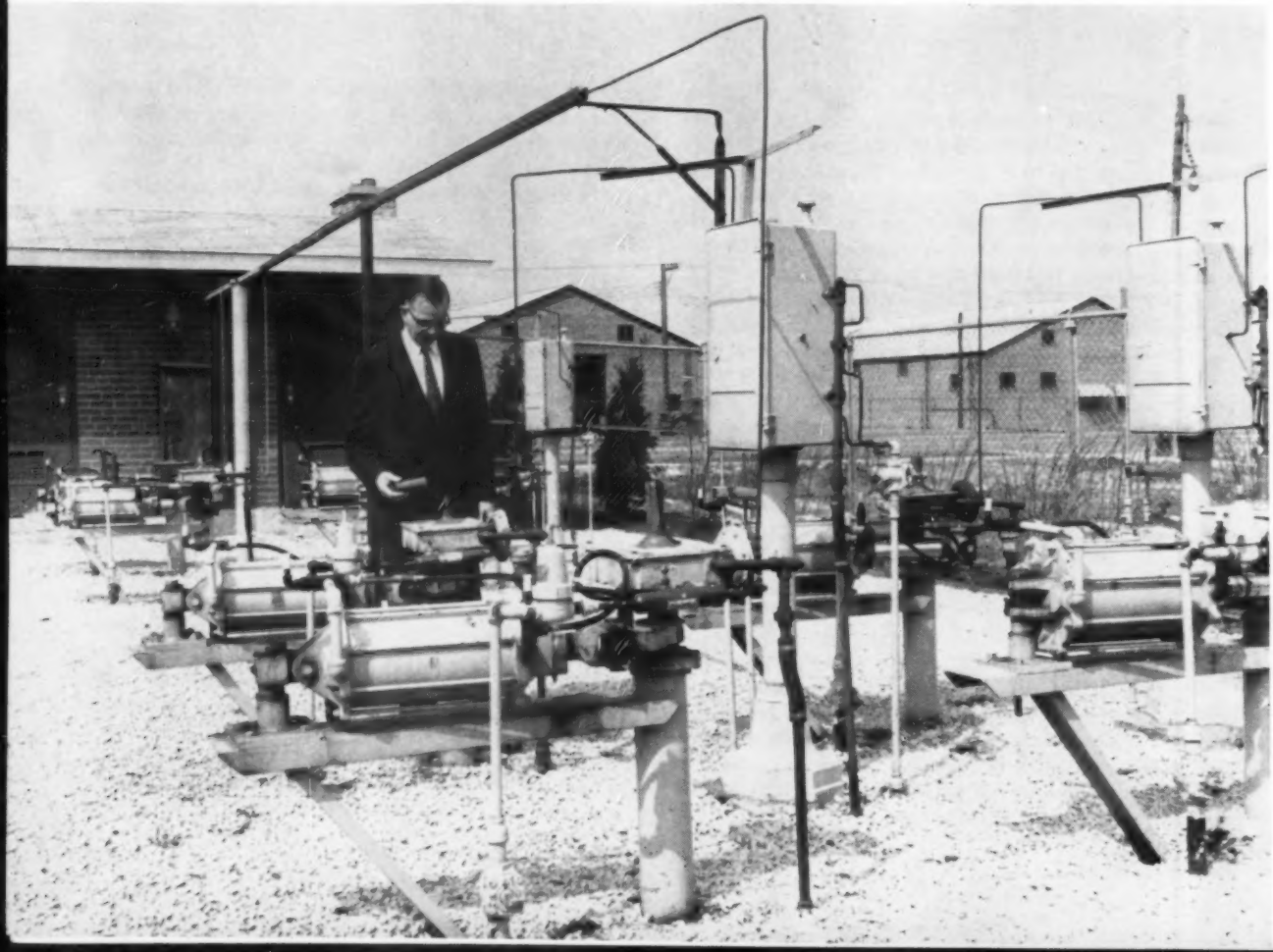
tolerance resulting in maximum utilization of facilities without penalizing the company.

Northern Illinois Gas Co.

CONTINUING on our tour to Bellwood, Ill., we looked in on the operations of Northern Illinois Gas Co., under the direction of Marvin Chandler, president. When questioned as to the approach of his company to automation, Chandler replied, "Northern Illinois is most interested in exploring the possibilities of realistic automation and will utilize automatic controls within its system as they are determined to be justified." Northern Illinois has established itself in the forefront of distribution companies in its acceptance of automatic controls. It has a very aggressive policy of attacking the problem of automation through evaluation. NI-Gas is now studying the use of thermoelectric generator units as manufactured by Minnesota Mining & Manufacturing Co. and by Westinghouse Electric. Its initial installation was a 10-w unit used for cathodic protection on a pipeline near its testing laboratory in La Grange. The company has plans for further evaluation of thermoelectric generator units yielding a higher power output.

The utilization of a thermoelectric generator as a power source for cathodic protection, though not unique in principle, represents a breakthrough in application. The unit manufactured by 3-M Co. develops 10 watts of output with 1 cu ft of natural gas per hour input. Based on a heat content of 1000 Btu per cubic foot, this represents a conversion efficiency of approximately 3 per cent. Although this is extremely low, when the availability of gas supply and non-availability of electric power are considered, the resultant power output may prove to be of considerable value to the gas industry in providing a power source for future operations in remote locations. This will be discussed in a later article in conjunction with the operation of field gas wells for full automatic control.

Harold Schwalm, superintendent of storage for NI-Gas, discussed a computer scheduled for delivery early this summer. This computer was purchased through Information Systems Inc. and will augment the functions of dispatching personnel. The machine is capable of extremely high-speed operation and will bring data from the field into computer logic circuitry at the rate of 47 items per second. It will have a memory storage capacity of 4096 words, and an additional 4096 words of memory may be added at a



later date without interrupting operation of the computer. This added storage is contemplated to cover Northern Illinois' 10-year program of operations. Data are brought into the dispatch center from remote locations by use of Bristol telemetering equipment and leased wire lines.

In the application of the computer to NI-Gas operations, Schwalm stated that they would utilize a minimum amount of visual display and would print out the desired data from computer memory only as required by the dispatcher. In on-line application of the computer, Northern Illinois will introduce to it the coefficient for each meter tube, the pressure limits for each station, and the desired flow rate for each station. Digital transmission of information from each station will include static and differential pressures and the temperature of the flowing gas.

The computer, through internal programming, will calculate the gas volume, compare this flow rate with the desired flow rate and emulate a signal to the meter station as to the differential setting required to obtain a desired flow rate. This differential data will be introduced into a differential controller and will position a restrictive device in the flow line to give the desired flow rate.

In addition, the computer will scan existing pressure conditions at the station and compare this value with limits set into the memory storage of the computer. An alarm will sound in the dispatch center if pressure is out-of-limits. It is proposed in the future to utilize the computer in an off-line operation to evaluate and optimize volumes through each station, taking into account contract conditions on flow rate, gas takes and price provisions. The computer will then print-out the source of the most economical gas to accept into the system.

This utilization of a computer may well revolutionize operations of distribution companies since, as foreseen by personnel of Northern Illinois, the optimizing feature will be included as an operational function. Heretofore, optimizing has been limited to operations of a general accounting nature. The possibility of providing the dispatcher with a tool reflecting desired rates and pressures to maintain optimum utilization of the distribution network should yield maximum returns.

NI-Gas in the past has obtained on request by telephone contact, meter readings from a remote instrument whereby the remote station is contacted by dialing a proper code number; the count stored at the station is permitted to count-down through a stepping switch circuit; and is recorded in the dispatch office. Northern Illinois has used this equipment with some of its large industrial customers in conjunction with a positive meter, but has not extended its use throughout the system.

At left: E. R. Culp NI-Gas station design engineer, checks plug valve regulator operators for remote pressure and flow control at one of the company's stations. This unique assembly was designed by NI-Gas engineers.

IN SUMMARY

There is a growing awareness among personnel within the gas distribution industry that further application of automatic control equipment and high speed computers can be realized in their operations with resultant benefits to their customers and stockholders. To date, the extent of use of automatic controls has been, in most instances, restricted to the well-known arts of telemetering and remote set-point; and, to a very limited degree, utilization of computers for summarization and tabulation.

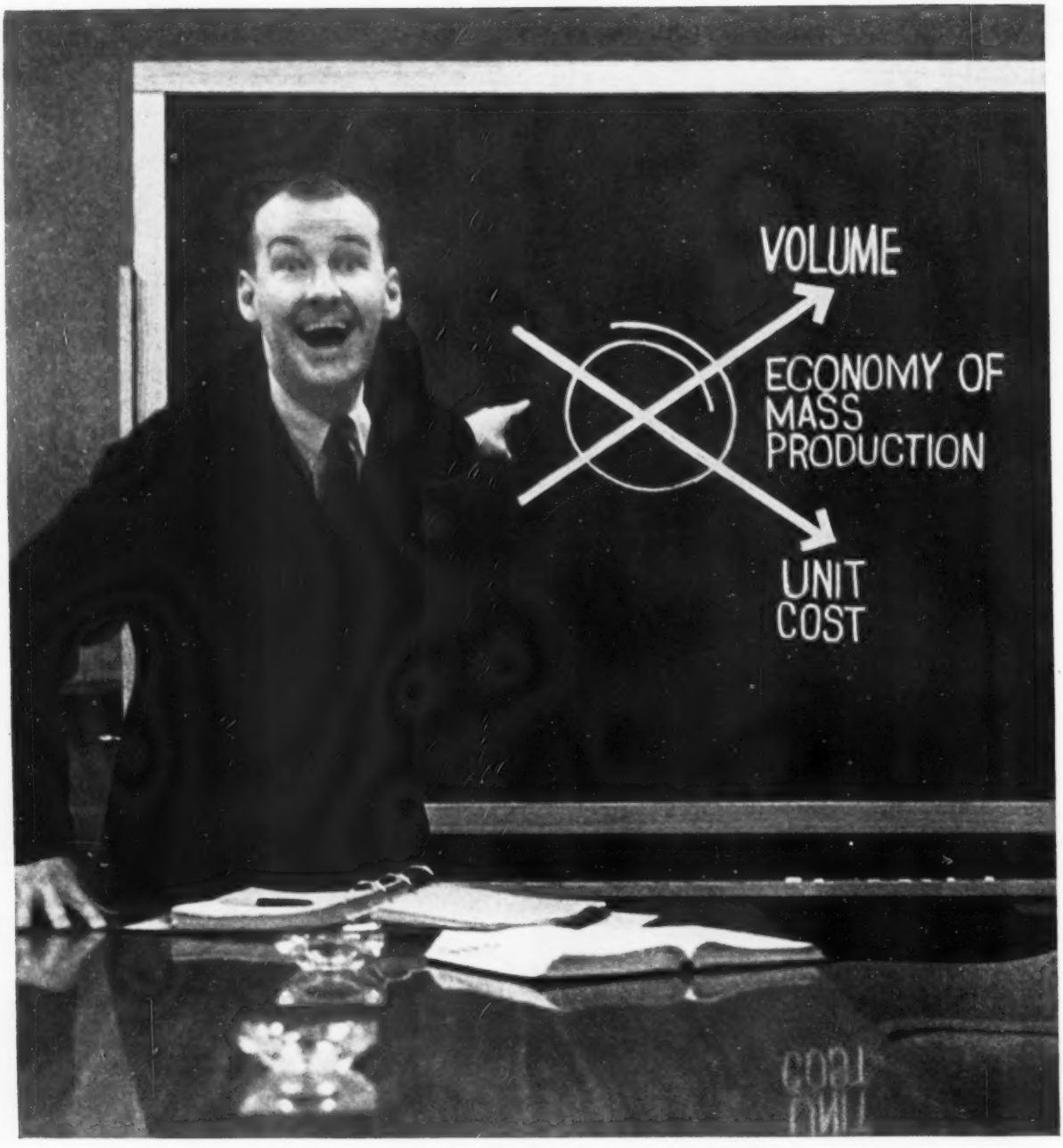
The growing trend is toward more extended application of electronic computers and feed-back instruction. However, as has been pointed out before, *this step in the adoption of automatic control must be based on sound engineering and economic considerations.*

There have been advances made by the sales division of one large gas transmission firm in the field of development of a device to assist in the speed and accuracy of reading domestic meters. However, this device does not eliminate the necessity for a meter reader performing a perfunctory task of checking all meters on the system each month. There appears to be a need for a device with which a domestic meter might be read and kept under surveillance by a controlling device, such as a high speed computer, that had available off-line time for such a supervisory function.

The problems presented by peak load demand resulting from adverse weather conditions entering a company's service area necessitates the use of storage capacity where available, and poses the problems of introducing gas into storage. Compressor units, such as used by Southern Counties, may well be modified to serve this function.

Utilization of gas power to furnish prime activation of thermoelectric generators to achieve electric power output permits a new look at cathodic protection. This type power unit on complete development should find widespread use in the gas industry.

NEXT MONTH: We shall turn to the facilities of gas transmission companies in the July issue and review the philosophies and installations of those companies that are more active in acceptance of the use of automatic control. ■



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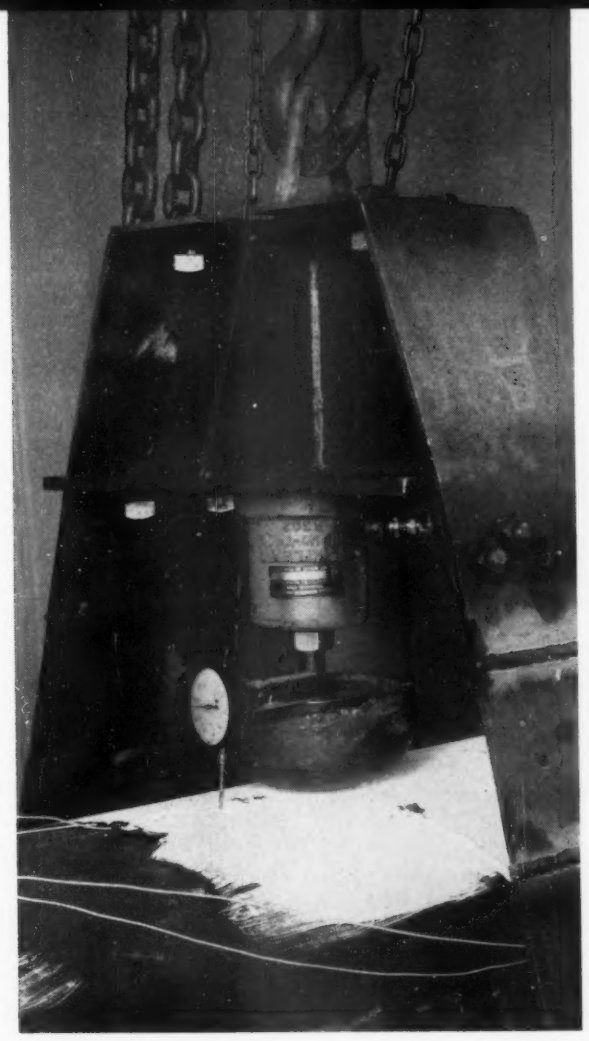


Apparatus used to produce artificial defects in line pipe. With this equipment, artificial defects of various sizes and shapes were produced to study their behavior under internal pressure and with changes in temperature and longitudinal stress.

A report on AGA's line pipe seminar

By KEN KRIDNER • Engineering Editor

SPEAKING before representatives of 39 gas industry companies attending the American Gas Association Line Pipe Seminar in Dallas, March 23-24, L. T. Potter, president of both Lone Star Gas Co. and American Gas Association, set the pace for the meeting when he said: "In our industry, we need more research planning. This must come not only from those who are scientists and technicians, but also must include the thoughts and abilities of management."

The two-day seminar was designed to permit a full report from personnel of Battelle Memorial Institute, Columbus, Ohio, on its activities researching design and materials for line pipe under the supervision of the line pipe research committee of AGA. The basic intent of the research program was the formulation and instrumentation of a constructive program for the gas industry that would continue the excellent safety record that has been compiled by gas companies in their operations to date.

B. D. Goodrich, vice president of Texas Eastern Transmission Corp. and chairman of the line pipe research committee, opened the session with a review of the establishment of the committee and its program. There were people in the industry, Goodrich said, who "felt that thickness was the only criteria in a gas pipeline." Included in the work of the line pipe committee was investigation of long pipeline failures (one-half mile or more)—as to why a fracture could propagate such distances, why the propagation approximated the speed of sound, and what preventive measures could be taken to protect against this type failure. To accomplish this task, the committee assigned the project to a research agency operating under its supervision. Stressing importance of continued efforts to improve pipe and pipe testing techniques, Goodrich pointed out that the largest portion of fixed cost of a transmission company is its pipeline.

Dr. G. T. Hahn of Battelle discussed the history of brittle fracture (or cleavage fracture as we will use the term hereafter) in steel. Cleavage fractures can be traced back to the mid-nineteenth century when the open hearth process became available. Early failures were found to have several points in common: (1) they all occurred in riveted structures, (2) the failures occurred in relatively cold weather—January through March, and (3) the speed of propagation of fractures was extremely fast.

Later failures in ships and bridges invariably started at either cracks in welds, hatch corners or other stress concentrators and the majority of them failed at low temperature. The most publicized of these ship failures occurred during the use of the Liberty and Victory ships in World War II—when on Jan. 6, 1943, the S. S. Schenectady broke in two and sank at the dock in Portland, Ore. The temperature at the time was 26 deg F. Observers at the scene stated that they had heard a loud report prior to the sinking of the ship. Subsequent tests revealed a crack of cleavage fracture.

Hahn next explained the difference between cleavage and shear fracture. A shear fracture will normally occur at a 45-deg angle to the surface, indicating simple or multiple slip: will have a dull appearance, and will propagate at a relatively slow speed permitting the pressure relieving wave to outdistance it and, therefore, hold the length of the fracture to a minimum. A shear fracture will normally occur at the higher temperatures.

The cleavage fracture will occur on a plane perpendicular to the wall of the material. The surface of the crack will have a very distinctive crystalline appearance, herringbone in design, pointing toward the origin of the failure. The crack will occur at low temperatures and can propagate at high speeds. Tear will often occur in a sinusoidal wave pattern.

In describing why a flaw or crack becomes unstable (as opposed to a stable condition) and the conditions for instability, Hahn drew an analogy to a bow and arrow. When the bow is stretched, elastic energy is stored. When the arrow is released, the stored energy is transferred to the arrow. Likewise, elastic energy stored in pipe is released when a crack tends to grow. When an arrow is first released, air resistance is negligible. Hence, all stored energy is transferred as kinetic energy to the arrow.

If energy required to fracture pipe is defined by the term W, then as the crack size increases, the value of W decreases. Unstable cracking will occur when the elastic energy stored in the pipe is equal to or greater than the work required to fracture.

The speed of a crack is affected by a number of factors including the energy required to fracture and the kinetic energy of the material behind the crack moving apart.

Hahn stated that unstable cracking is favored by a large amount of elastic energy and a small amount of energy required to fracture. In extremely low temperature, evidence has been found that simple or multiple slip (shear fracture) will tend to interfere with itself and cause cleavage fracture. Every material will have a different curve when plotting the per cent of cleavage fracture versus temperature. Shape and position of the curve on the graph will depend on chemical composition and rolling properties of the steel.

In between the temperatures at which pure shear and pure cleavage fractures occur there is a range called the "transition temperature range." Date from Charpy tests have been plotted in foot-pounds versus temperature. There have been efforts to establish a base or standard foot-pound intersection of the plotted curve being termed the "transition temperature."

To date there has been no definite value established for a standard, though the values most referred to by Hahn were 10 or 15 ft-lb. The value of the "transition temperature" for correlation purposes appeared to be doubtful in view of the varying curves resulting from the effects of chemical composition and rolling of steel.

Dr. George H. McClure of Battelle, group director for solids Mechanics Research, discussed the pipeline fracture problem and stated that the use of tensile test data does not provide criteria as to when unstable fracture might occur. McClure added that we need to develop techniques and tests to define materials which are not subject to cleavage fracture and thus attempt to prevent it.

It has been found that unstable failures have initiated at a defect of one kind or another. This raises question as to which defects are serious and which are not. Secondly, it has been found that cleavage fractures can propagate at a high rate. A cleavage fracture does not require as high an energy to fracture as a shear fracture.

In an effort to determine the cause of long pipeline failure, Battelle and gas industry personnel endeavored to duplicate this type of failure. A full scale test under controlled conditions was conducted at Athens, Ohio, beginning in 1954. These tests were designed to yield data reflecting behavior and type of fracture at four different temperatures and to permit, if possible, a correlation of test data with laboratory test. The test section used was a 30-ft joint of 30-in., 0.375-in. wall, 5 LX-52 line pipe located in the middle of a segment of pipeline 330 ft long. The idea, as expressed by McClure, was "the 330-ft section was long enough to simulate an actual pipeline under the test conditions."

Four different sections of pipe were tested to destruction at different temperatures. The pipe in each case came from the same mill heat and had a yield strength of approximately 58,000 psi, with carbon and manganese contents of 0.27 and 1.05 per cent respectively. The test section was pressured to the 920-to-940 psig range prior to the forced failure. Before the test, a V-notch 20 in. long, milled to a depth of 28 per cent had been placed in the section. The tests were run at temperatures of 20, 58, 90 and 130 deg F.

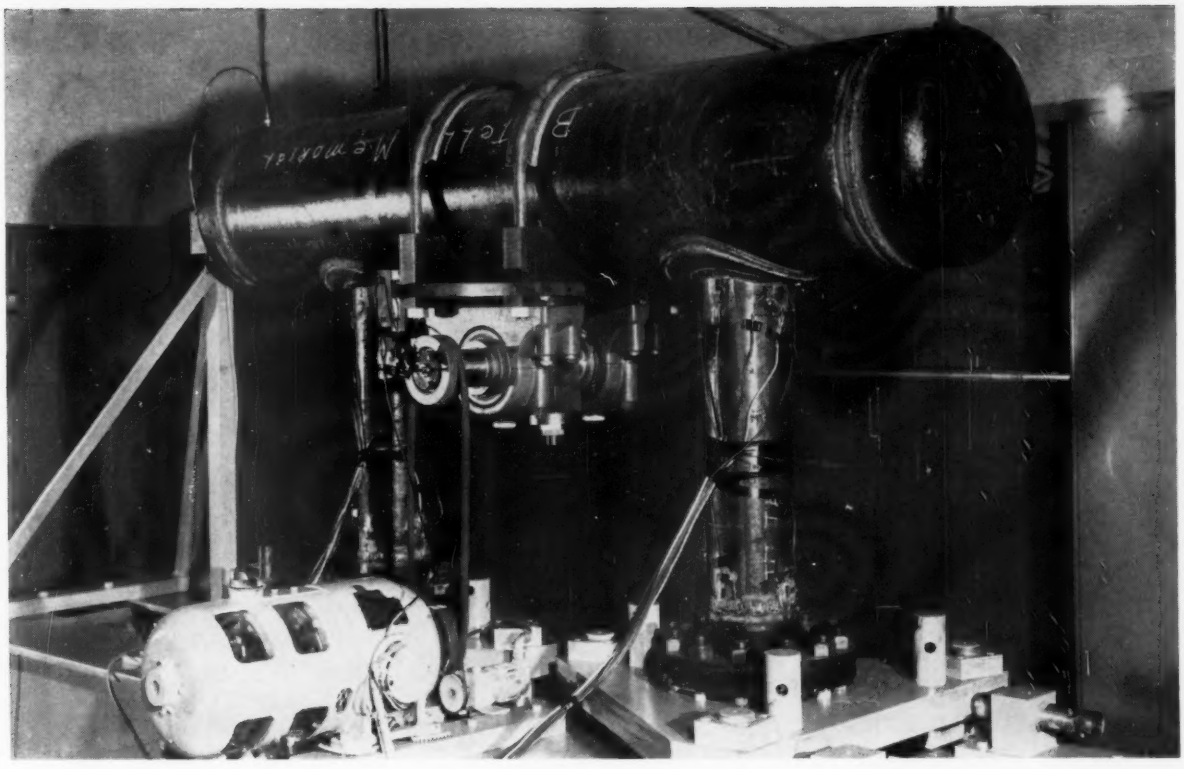
It was found that crack speed at the lower temperature test was 3000 to 5000 ft (est.) per second (fps), reducing to 2600 fps at 58 deg F, to 1500 fps at 90 deg F and to 900 fps at 130 deg F.

Studies of the cracks from the two low-temperature tests indicated both had failed in cleavage. Results from the test at 90 deg F indicated a cleavage fracture; but, there were several indications of shear fracture, and one crack that attempted to branch out.

The test at 130 deg F resulted in shear fracture—one crack traveled along the top of the test section and stopped at each end by tearing around the girth weld.

Results from the full scale tests permitted correlation of Charpy test data with field test data. In future testing toward the objective of defining desirable properties to prevent propagation characteristics, experiments can be run using short lengths of pipe using water. A pocket of gas will be used for additional energy. From this type of test, the type of fracture and possibly the speed of propagation can be determined.

F. W. Boulger, also of Battelle, reviewed steel making practices, stating that the majority of steel used for line pipe comes from semi-killed ingots. Ductility and toughness, two important factors in the strength of line pipe, are affected by rolling practices and by ferrite grain size. The more cross rolling, the more uniform the properties.



Above: Equipment to study effects of cyclic loads on branch connections. Here a 16-in. diameter header with two pad-reinforced risers is being subjected to cyclic axial loads. The apparatus strapped to the center of the riser is a rotating-off-set mass—it provides the cyclic excitation. Below: An instrumented test specimen used in the branch connection reinforcement program.

P. J. Rieppel, chief of Metal Joining Division of Battelle, reviewed pipe fabrication methods. These are seamless, submerged arc welding, flash welding, low frequency resistance welding and high frequency resistance welding. The latter three require no added metal. Instead, the edges of the pipe are heated and then forced together. These methods have an identical problem presented if the skelp is split so that plate edges are from the center of the ingot, resulting in problems related to bent fibers. This may be overcome by proper programming to insure that edges are from the outside of the ingot.

Rieppel discussed testing methods of the weld, stating that the weld is loaded to the yield strength of the steel when the pipe is expanded. The section is then tested hydrostatically to 90 per cent of yield. Some mills are now using inspection methods such as magnetic particle and ultrasonic for the detection of flaws.

Bougler discussed the effect of the elements carbon and manganese on tensile strength. An increase in either element will result in increased tensile strength. Manganese will tend to increase the strength and toughness of the steel as its percentage is increased when the carbon content is held constant. Transition temperatures are not directly related to tensile properties of steel, but rather are controlled by the chemical composition and the rolling conditions. Cold working and increased pipe thickness both reflect adversely on transition temperature, though cold working increases yield strength.

Compressor and instrument shed used in full-scale tests. Compressor was used to obtain desired pressure in tests to study fracture propagation. Instrument shed housed strain gauge equipment and speed and temperature measuring devices.

Battelle's R. J. Eiber discussed pipe defects and their effect on pipe failure. In a research program to investigate the behavior of defects, three types of artificial defects were used: (1) stress concentrators in round pipe, (2) plain dent, and (3) dent with a stress concentrator. The stress concentrators were a V-notch, a weld crack or a gouge.

Of interest in Eiber's talk was the point that although a number of tests had been conducted on defects of the second type over the range of 20 to 130 deg F, no fractures have been experienced from a plain dent.

In an effort to determine the effect of variations in daily operating pressures, tests were made at 30,000 cycles simulating an 80-year life of daily pressure fluctuations. The section was then tested to failure. Ultimate bursting pressure was found to be equivalent to that of new pipe. Thus, it was concluded that variations in daily operating pressures had no adverse effect on pipe strength and could not be considered the cause for failure of pipe that had previously been tested to a higher pressure. Tests were also made varying temperature from 15 to 120 deg F. Again, no adverse effects were experienced.

McClure in summarizing defects in pipe, pointed out that gouges and dents should be picked up by field inspectors. Metallurgical defects due to quenching at high temperatures should be detected by the manufacturer at the mill. He stressed that welders' identification markings should not be stamped or imprinted by hammering on the pipe.

T. J. Atterbury, of Battelle, discussed branch connections and secondary stress work, reviewing the investigation done to determine field measurements of external forces and to measure, experimentally, forces in branch connections due to internal pressures.

Reference was made by several of the speakers to factors influencing cleavage fracture or to improvements that might be looked forward to in the future in line pipe development. McClure stressed that tensile test data does not provide the necessary information to indicate when unstable fracture might occur. Hahn indicated that it would be desirable to use a steel which had shear fracture instead of cleavage fracture properties. Boulter stated that transition temperature is affected by grain size and that grain size is affected by the rolling temperature. Plate rolled at 1650 deg F has a smaller grain size than plate rolled at 1850 deg F. Transition temperature is affected by chemical composition and rolling conditions. Also, transition temperatures are adversely affected as the pipe thickness increases. Dr. McClure has stated that with the same stress level, there is more elastic energy stored in the wall of large diameter pipe and, again, he also said that the use of thicker wall in pipe is not the solution to eliminate cleavage fracture.

Evaluating the above comments, the resultant conclusion would appear to be that either the use of a higher tensile strength steel, permitting a minimum wall thickness as larger diameter pipe is produced, or a close control of chemical composition of heats—together with controlled rolling will be required to insure that any fractures that might occur will be in shear and thus localized. The development of a test that can be used to define susceptibility to cleavage fracture is desirable.

Potter in his comments before the assembled group echoes the sentiments of many in industry who are constantly seeking improvement in line pipe and line pipe testing techniques when he said—"Now, research is no longer only enthusiastically received but is demanded." ■

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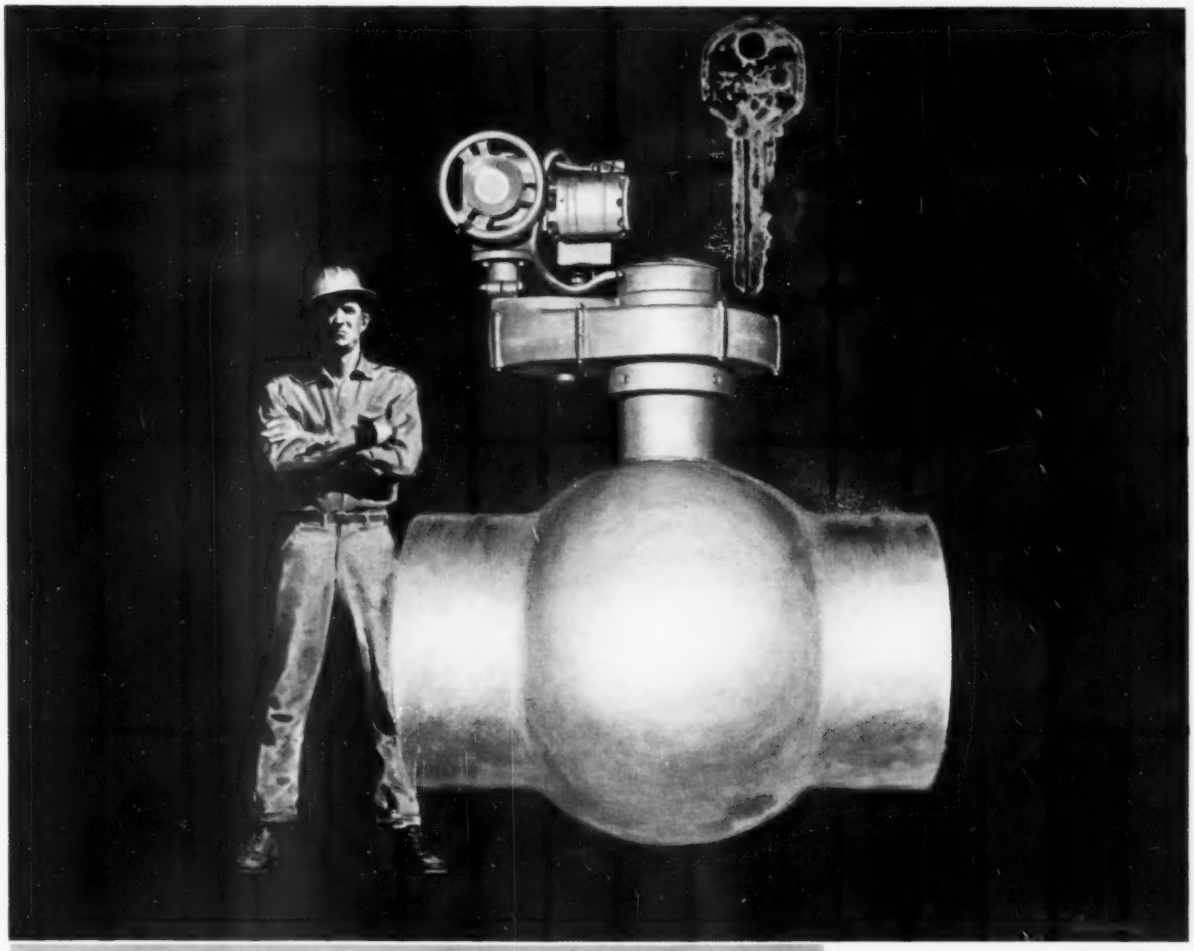

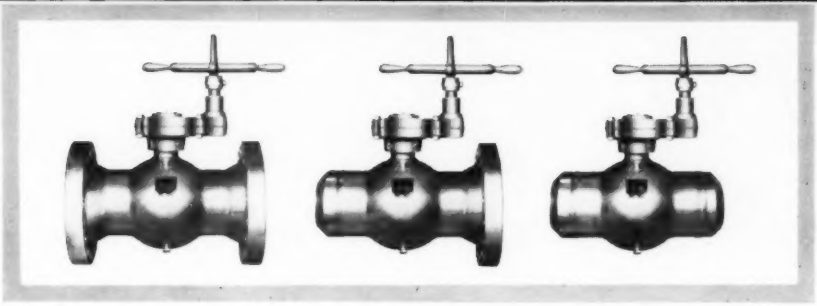

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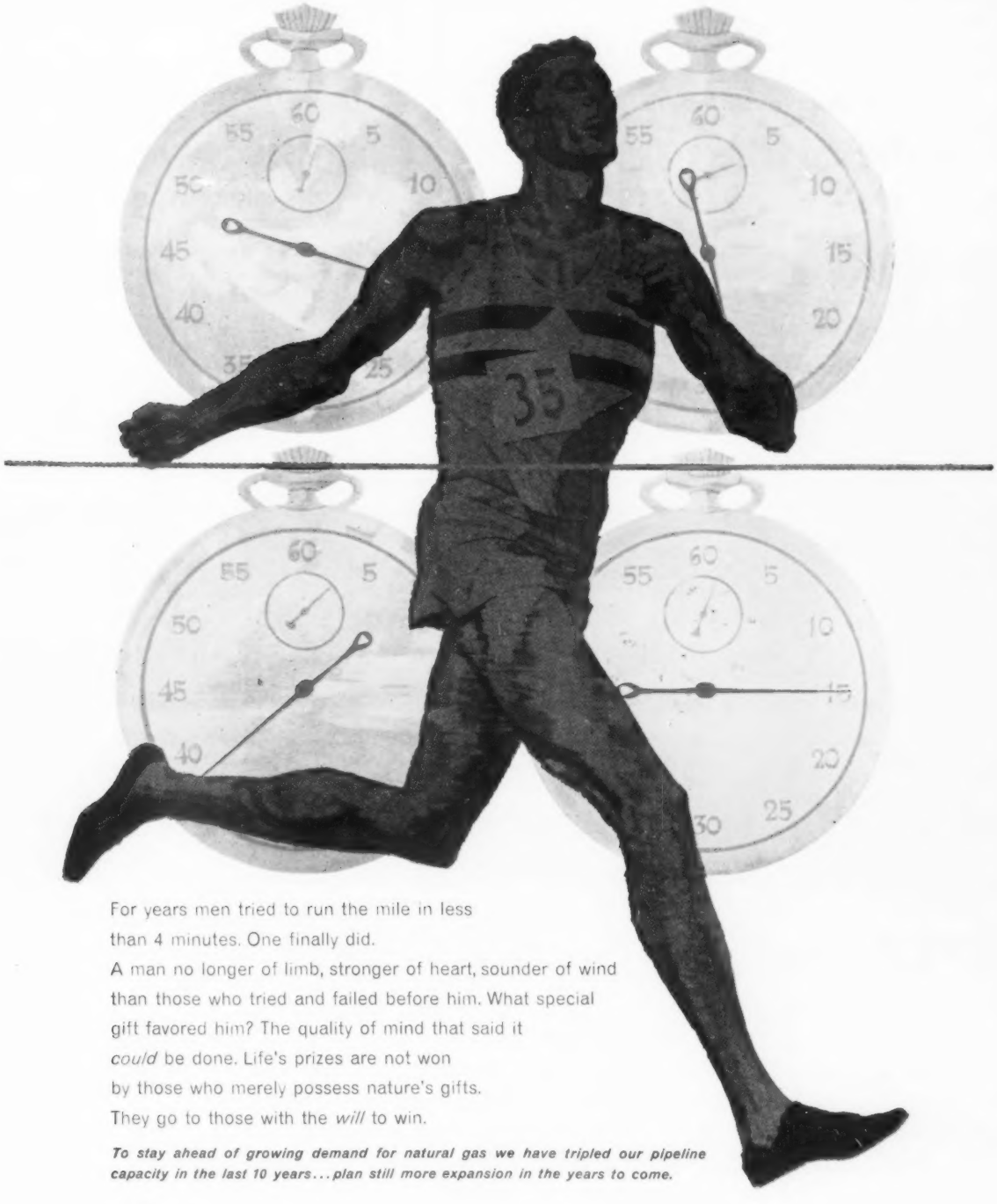

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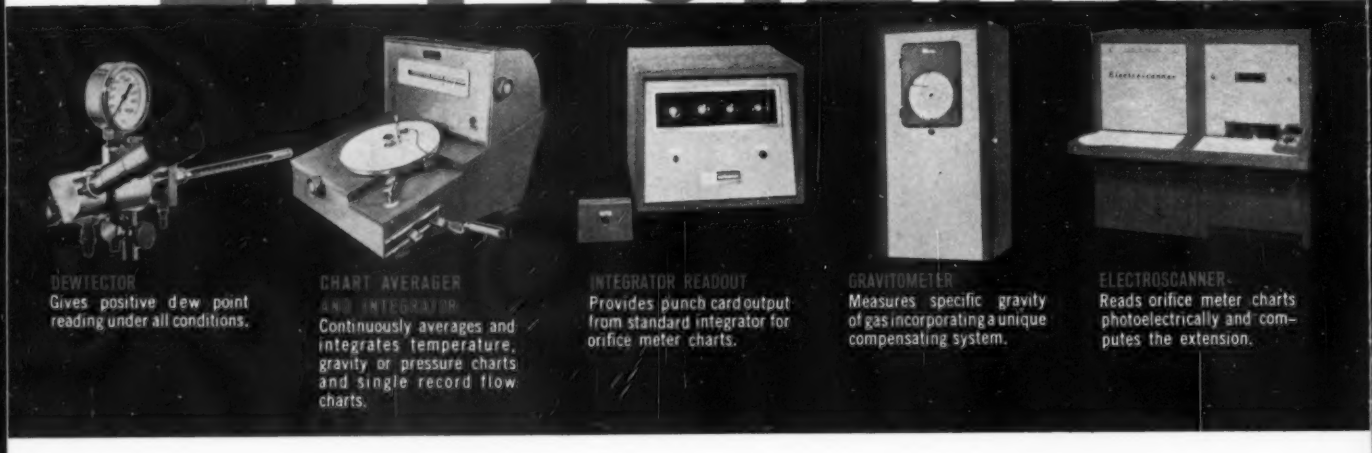

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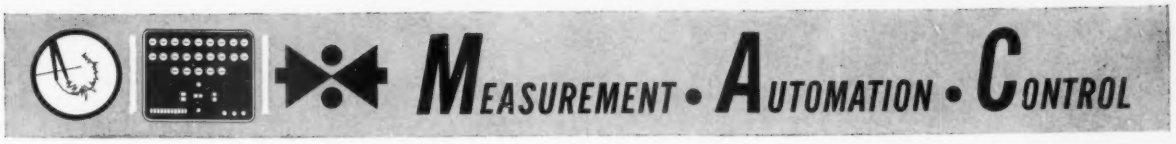


By KEN KRIDNER
Engineering Editor

The measurement-dispatching relationship

THE art of gas measurement has improved since publication of the first industry measurement standards. An observer at the recent 36th Southwestern Gas Measurement Short Course, Norman, Okla., would have met many persons both in industry and manufacturing who have made a career of measurement. Each large gas transmission company has a department responsible for accurate metering and calculation of gas flows.

Within recent years a second department in gas companies has also concerned itself with gas flow data, but for control purposes. As the scope of operations in the field of telemetry and remote control have enlarged, the control center or dispatch center has been vitally concerned in the volume of gas handled in a gas company's network. Thus, it has been quite common to see duplicate meters across a single orifice fitting, one taking data for use by the measurement group and the other telemetering data into the control center.

It would appear to be only a question of time until this duplication of effort is resolved into a single measurement that will be telemetered into the control center and used for billing and control. But, data transmitted into the control center at this time is not of the degree of accuracy that will permit its use for billing. As industry demands improved accuracy and reproducibility, manufacturers will refine their hardware to achieve an end result consistent with industry desires and AGA Measurement Committee standards.

The problem can be condensed to four principal points:

(1) Can manufacturers of hardware necessary for measurement and handling of flow data produce a unit yielding an exact single bit of information at a price that will permit its use? Present day studies tend to indicate this unit will be either an electronic device incorporating components permitting correction for gravity, supercompressibility and temperature, or a unit utilizing a density instrument.

(2) Will the measurement unit conform to AGA Committee Report No. 3? Use of the density instrument possibly will require modification or enlargement of the scope of the current AGA Committee Report.

(3) Will the producer or customer accept a transmitted volume? Indications are that the producer or customer would be in agreement with use of data received from a remote metering location after an adequate proving period had elapsed and providing satisfactory conforming data were available to insure that data received was in exact agreement with data transmitted.

(4) Could use of transmitted data be accomplished under existing contractual agreements? Many contracts provide for revision of measuring procedures upon mutual agreement; however, it is most likely that most contracts would have to be revised.

What are the advantages and disadvantages in utilization of data transmitted to a central control office? A principal advantage of course would be elimination of duplication of effort. This would resolve the old adage of "if it is worth measuring, it is worth measuring right."

A second advantage would be immediate access to flow data at the completion of a billing cycle or regulatory period. Current procedures wherein charts are removed and calculated may cover monthly cycles for which the beginning and ending time varies as much as 10 to 12 hours. Use of data transmitted into the control center would permit electronic scanning of all meters within minutes (considering access time rates of up to 50 items of data per second on new types of equipment).

The outstanding disadvantage would be the resultant maintenance problems with the introduction of extensive electronic hardware. Another immediate disadvantage would be the required extension of channeling equipment and the problems of limitation due to regulatory control.

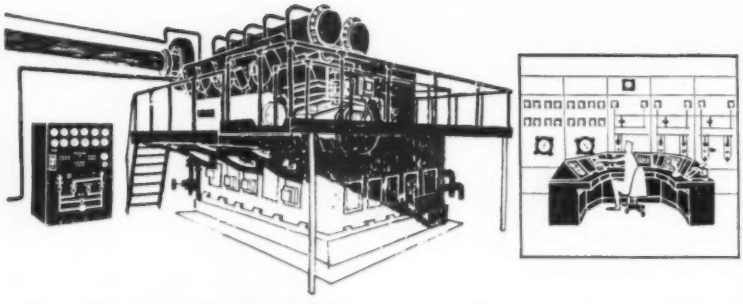
There will be some who say that use of such new equipment would eliminate personnel in the measurement department who have spent many years in this work and whose efforts would no longer be required.

It is doubtful that this would be the case since the hardware used, whether mechanical or electrical, would function in accordance with existing requirements for determination of the variables of gravity, temperature and pressures. Measurement personnel would find it necessary to enlarge their skills to encompass the mysteries of electronic hardware; however, they would find the end result to be a more interesting and challenging work. In addition, the measurement personnel should find a greater reward for their efforts as they upgraded their skills.

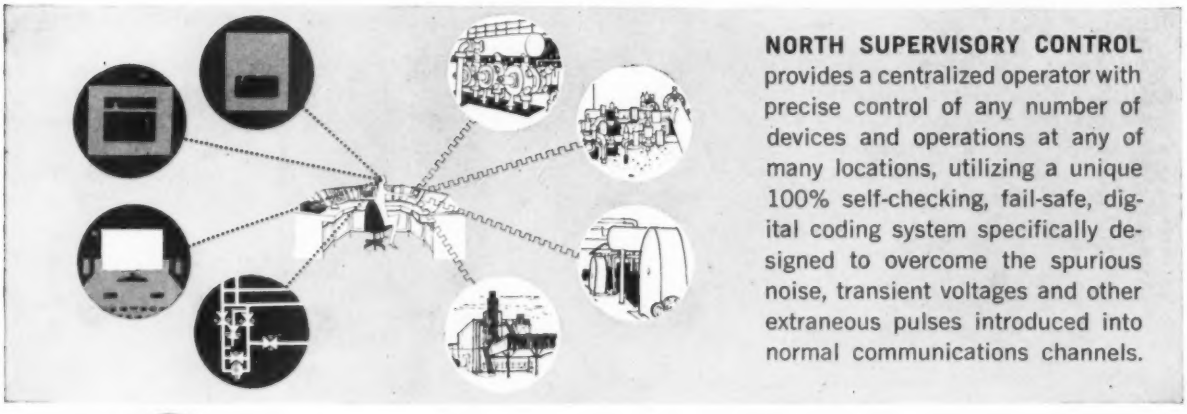
Continued on page 148

North Electric Paricode® for pipe line automation

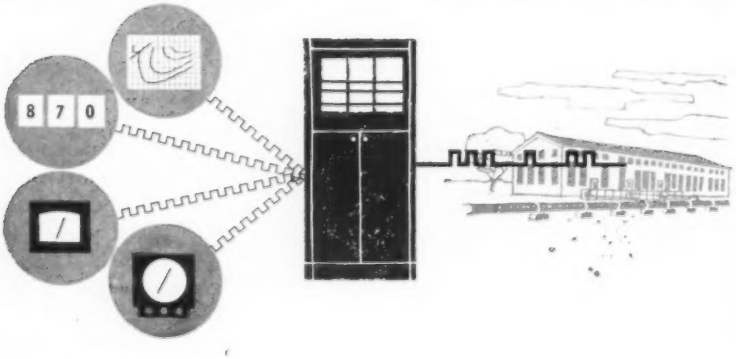
The structure of full scale pipe line automation can be divided into three major phases—North Electric brings to this field a design philosophy of progressive automation that makes it possible for companies to automate in these most logical and economical steps.



NORTH SEQUENCING UNITS provide automatic and fail-safe start-up and shut-down of all types of engines, motors and turbines with complete safeguards for emergency shut-down, fault identification and remote indication, following engine manufacturers' recommended procedures combined with operating companies' individual requirements.



NORTH SUPERVISORY CONTROL provides a centralized operator with precise control of any number of devices and operations at any of many locations, utilizing a unique 100% self-checking, fail-safe, digital coding system specifically designed to overcome the spurious noise, transient voltages and other extraneous pulses introduced into normal communications channels.



NORTH COMPUTER CONTROL makes remote stations independent of control commands or manual adjustments to maintain optimum operational status during variations of operating conditions and provides monitoring and alarms required for reliable unattended service.

North Paricode Systems bring you integrated communications, control, instrumentation and data processing from a single organization with the capability to design, engineer and produce reliable, fail-safe systems for progressive or full automation to your exact requirements.

For detailed descriptions of North Electric Paricode Systems

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Communications Tele-Control

The war over 'Telpak'

By F. VINTON LONG

YOU would think everyone would be real happy if his telephone rates were reduced.

A lot of people are happy right now, but some are not so pleased. As a result a new cold war has started, with the fracas winding up, as usual, in the lap of the FCC.

Maybe I had better explain just what "Telpak" is. It is a sales name set up by AT&T to identify its offering of a multichannel package between two points, and only two points, at a bargain rate. A bargain rate, that is, if you need a certain number of channels. They offer this package, which to the pipeline group is called a "pipe" on a mileage basis, at the rate of $15 per mile per month for 12 voice type channels, $20 for 24 channels, $25 for 60 channels up to $45 for 240 channels. You can drop off channels at a nominal monthly connection charge.

It is really a broadband offering, and you can do anything you wish with it. You can send facsimile or high speed data; and if you use it for voice channels, AT&T will rent you the terminal multiplex gear.

As you see, per-mile monthly cost on a voice channel basis becomes quite cheap, ranging from $1.25 for the 12 channel offering, down to $0.19 for 240 channels.

You can also use this on an alternate-use basis for either data handling or voice channels.

Right there is where the hassle has started.

There is a feeling in some quarters that AT&T has offered this cut rate package as a last-ditch effort to dry up private microwave expansion after they and other common carriers were defeated in their effort to convince FCC that privately owned microwave should not be available to business and industry on a liberalized and permanent basis. In other words, the offering is a direct result of the outcome of FCC Docket 11866, which had a lot of intervenors, including the oil and gas industry.

AT&T virtuously denies this and says that it is mere coincidence that the offering came on the heels of the FCC decision.

I have heard the rumor that some of the microwave suppliers feel that this offering will dry up their sales to private users, but increase them to the common carriers. They base this on the idea that AT&T has installed special equipment such as microwave links to provide their broadband channel offering and, therefore, will install more microwave links to provide additional Telpak services in the future. In other words, that a lot of microwave links will be set up to provide channels for many Telpak customers, almost on a custom basis.

I don't believe that this is so. As far as I can see, the Telpak channels will be derived from whatever long line facility is available in that area, and no special links will be set up for this purpose, nor have they been installed for the present offering. Actually, there are not thousands of new customers waiting to snap up the Telpak service. What it boils down to is that the customers are already being served; all that happens now is that they get a reduced rate for existing service, where the Telpak package can be economically applied.

Therefore, I do not see any boom to the microwave suppliers in their sales to the common carriers. I think their potential sales to businesses and industry will be drastically cut from the rosy thinking of the immediate "post-FCC Docket No. 11866" period; however, I don't think it will affect their sales to the oil and gas industries one way or the other.

Right now the two immediate intervenors before the FCC are Motorola and Western Union. They both want the new Telpak tariff carefully studied.

Here are some quotes from "Industrial Communications Reports" of Washington, D. C.:

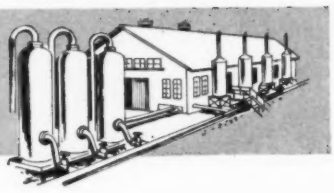
"AT&T pointed out (in a letter to FCC) that 'the choice of the route of the physical facilities is made by the telephone company. We believe this is essential in order to make the most efficient use of plant and to permit prompt furnishing of service. This is true of Telpak as well as of other services offered by the telephone company. . . .'

"The telephone company's answer to the FCC, regarding the situations described in the agency's letter in which a customer requests service over a diversity of routes, with or without specifying the actual routes, agreed that 'there is no provision in our tariff under which a customer has the right or option to obtain diversity of routing or facilities on request, with or without additional charges' — excepting special arrangements designed to meet specific military requirements. . . .

"Upon analysis of the Western Union petition for an investigation, AT&T said, it is 'readily apparent that Western Union, while seeking protection from the competition of AT&T, ignores completely the threat to both carriers of the private microwave competition which

Continued on page 150

GAS PIPELINE NEWS



Columbia signs for 6.2 trillion cu ft

Columbia Gas System is entering into a long-term gas purchase contract to buy some 6.2 trillion cu ft of gas reserves from a newly formed non-affiliated interstate pipeline company.

Humble Oil & Refining Co. will sell the reserves to the new company, Monterey Gas Transmission Co.

Under present plans, Monterey will ultimately transport more than 700 MMcfd from southwest Texas to Alexandria, La., for sale to United Fuel Gas Co., principal supplier of gas to other Columbia Gas System companies. Columbia Gulf Transmission Co., another Columbia affiliate, will transport the gas from Alexandria to Columbia's consuming area.

Under a letter of intent signed by Humble and Monterey, the new pipeline company proposes to:

1. Purchase Humble's present 30-in., 238-mile line extending from Humble's King Ranch gas plant in southwest Texas to its Clear Lake gas plant near Houston.

2. Construct a new 30-in., 216-mile line from Clear Lake to Alexandria, La. There it will tie in with Columbia Gulf Transmission's system.

3. Purchase from Humble in-place gas reserves totaling 3.5 trillion cu ft. Later, it will purchase additional in-place reserves from Humble totaling 2.7 trillion cu ft.

A letter of intent signed by Monterey and United Fuel calls for Monterey to sell gas from these reserves pursuant to a long-term contract with United Fuel.

Deliveries under the contract will run until 1986 or later and will be on a cost-of-service basis. Field cost of gas is fixed for the term of the contract on the basis of Monterey's investment in purchasing the reserves.

Monterey Gas will apply soon to FPC for the necessary certificates of public convenience and necessity. In addition, various financial details remain to be worked out.

The gas ultimately will be distributed by Columbia Gas System companies, and non-affiliated companies served at wholesale, to customers in Ohio, Pennsylvania, West Virginia, Virginia, Kentucky, New York, Maryland, and the District of Columbia.

Columbia's chairman, George S. Young, termed the transaction "most important . . . because . . . we will be assured of large additional reserves of a relatively firm price for 25 years or longer. This will tend to level off the upward trend in gas prices which we have been experiencing in recent years."

Deliveries from Monterey to Columbia are scheduled to start late in 1962.

Initial shareholders of Monterey Gas are Humble Oil & Refining and Lehman Brothers, the New York investment firm. After Monterey obtains FPC approval, and subject to SEC and other governmental agencies approval, it is contemplated that the new pipeline company will be financed by institutional loans and a public offering of its securities.

John R. McMillan, former executive vice president of Monterey Oil Co., will head the new company as president. McMillan represented Monterey as one of the organizers of Transwestern Pipeline Co. and seved as the first president of that company. Donlin P. Murdy, former vice president of Monterey Oil, will serve as vice president and treasurer of the new company. Directors will be McMillan and Murdy; H. W. Haight, executive vice president of Humble; and Frederick L. Ehrman, partner of Lehman Brothers and former chairman of Monterey Oil Co.

Panhandle's storage testing okayed

Panhandle Eastern Pipe Line Co. has a two-year temporary authorization to test its Waverly storage field in Morgan and Sangamon counties, Ill.

Preliminary testing was done from 1952 to 1958. In the present proceedings, Panhandle sought authority for further testing.

Panhandle has a maximum daily pipeline capacity of more than 1.25 MMcf. FPC examiner Harry W. Frazee, in granting the authorization, said evidence shows that market requirements of Panhandle's customers exceed the peak pipeline capacity. In order to supply additional amounts of natural gas, Panhandle must expand its transportation facilities or develop storage capacity. Panhandle contends that development of Waverly will be more economical than expansion of pipeline capacity.

Panhandle will inject up to 6 billion cu ft of gas into the St. Peter formation in order to evaluate reservoir and collection productivity and determine what facilities will be needed to operate the field if ultimately certificated by FPC. Total testing cost is estimated at $4.8 million, of which $2.5 was spent on Stage 1 work.

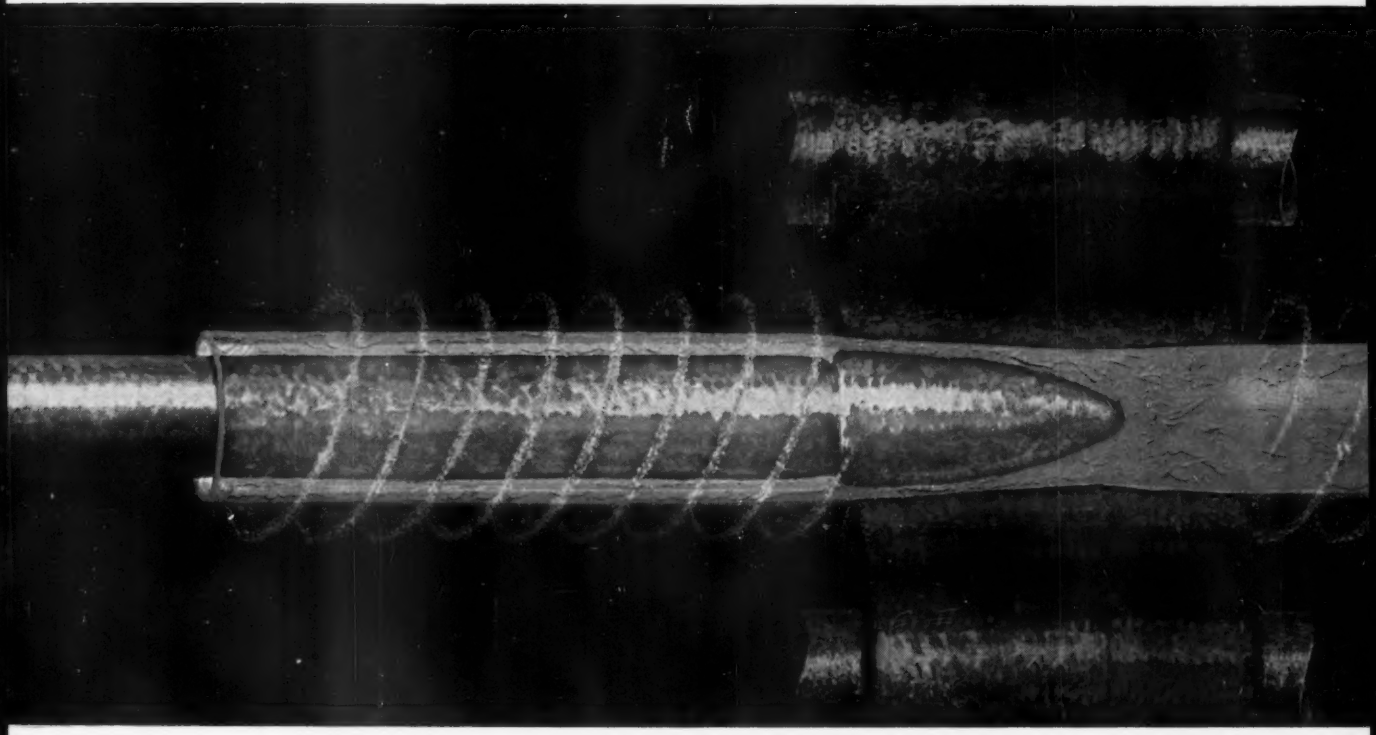
Northern wants to boost Redfield take

Northern Natural Gas Co. wants to expand use of its underground storage field near Redfield, Iowa.

The company asked FPC to amend its previously filed application which sought to withdraw 40 MMcfd. The new request would increase this withdrawal to 95 MMcfd.

Northern also seeks permission to construct a 1500-hp compressor unit at Redfield and to increase the present authorized inventory of gas in the Mt. Simon reservoir from 45 billion to 56 billion cu ft.

What a tough way to come into the world!



The piercing operation is one of the first steps in creating seamless line pipe from a solid section of steel. After we set the hot steel billet in place, we ram it. Spin it. Push its insides out. And stretch it into a tube many times longer than the original piece of steel.

Consider this grueling way that USS National Seamless Line Pipe is made. Need we say more about its strength or dependability? You can see why Seamless is the safest pipe in the world.

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Pacific Coast Distributors
United States Steel Export Company, New York

New compressor line introduced

A new line of single-stage, portable compressors was announced by Worthington Corp. at a press conference in New York City in mid-April. GAS Magazine and others were told by Worthington's Frank Nunlist, vice president-operations, that such compressors are readily available now in sizes of 85, 125, and 250 cu ft of air per minute.

But, of at least equal or perhaps more importance to GAS' observer was the fact that the company is offering these units with a one-year warranty (as compared to the current 90-day warranty practices).

Nunlist, who said the compressors will be produced in sizes most in demand, at lower operating costs, lower maintenance costs, and with greater stability, credited simple design as the basis for the improved warranty. Called Mono-Rotor units, they have only 79 parts as compared with 213 in the old two-rotor, two-stage models.

According to Fred Seel, general manager of construction equipment division, this simplicity has resulted in a compressor weighing some 20 per cent less. In the case of the 125-ft unit, this means a reduction from 2900 lb to 2300 lb.

The simple compressor design is made possible by an exclusive, Worthington-developed rotor-to-cylinder oil sealing. One cylinder, one rotor, one set of bearings, one high pressure seal and only one set of blades are required. Gears and an oil pump have been eliminated.

The Mono-Rotor units are the result of the company's five-year plan of market research, design, and test. Realizing that two-stage rotary compressors would eventually be replaced due to better designs emanating from advanced technology, Worthington explored such possibilities. Comparisons were made between Mono-Rotor, two-stage, and screw-type compressor designs. The results of such analysis (see table) convinced the company of the feasibility of the Mono-Rotor design. However, Nunlist was quick to point out that this is "not a new design but rather a new engineering development—a new concept."

In response to a question from GAS, W. H. Wheeler, sales manager of construction equipment division, noted that the Mono-Rotor compressors "lend themselves beautifully to power take-off operations. As a matter of fact," he said, "Southern California Gas Co. has already ordered 30 of the 85- and 125-ft units. Further," Wheeler added, "the advantages cited as being available presently in units up to 250 ft are achievable in units up to 900 ft."

COMPRESSOR COMPETITIVE ANALYSIS CHART

Feature or benefit	Mono-Rotor	Two-stage	Screw-Type
Design proven in construction industry	Yes	Yes	No
One Stage	Yes	No	Yes
Single Rotor	Yes	No	No
Main Bearings	2	4	4
Time Gears	No	No	Yes
Oil Sealing	Yes	Yes	Yes
Simple cylinder shape	Yes	Yes	No
Oil Pump Needed	No	Yes	Yes
Critical Alignment of Rotors	No	No	Yes
Total Weight	Less	More	More
Availability	Now	Now	?
Clutch	Yes	Some	No
Fewest Parts	Least	Most	More
Maximum Ambient Temperatures	125°	125°	115°
Warranty period	1 year	*90 days	*90 days
Field Proven	Yes	Yes	No

*(usual)

Automatically welds 36-in. pipe in the field

Since April 12, H. C. Price Co. has been automatically welding 36-in. pipe in the field.

Price, Crose-Perrault Equipment Co. and Hobart Brothers have developed the new welding process which permits welding stationary pipe under ordinary line-up conditions.

Site of the first field operation was on a section of Pacific Gas & Electric Co.'s 296-mile portion of the Alberta-California pipeline project now being constructed. (See photo.)

With the development of this process, it is possible to better control the uniform quality of the weld while welding pipe at a faster rate. The automatic weld is currently being applied following the hotpass using a CO_2 shielded arc with oscillation. The prototype machine now in use will be standardized and improved upon and made available to the pipeline industry at a later date. Development and current testing of the machine is under the direction of Barney V. Elliott of H. C. Price Co.

Although Price is using the new machine on 36-in. pipe, the machine can be adjusted and used to automatically weld pipe of all sizes.

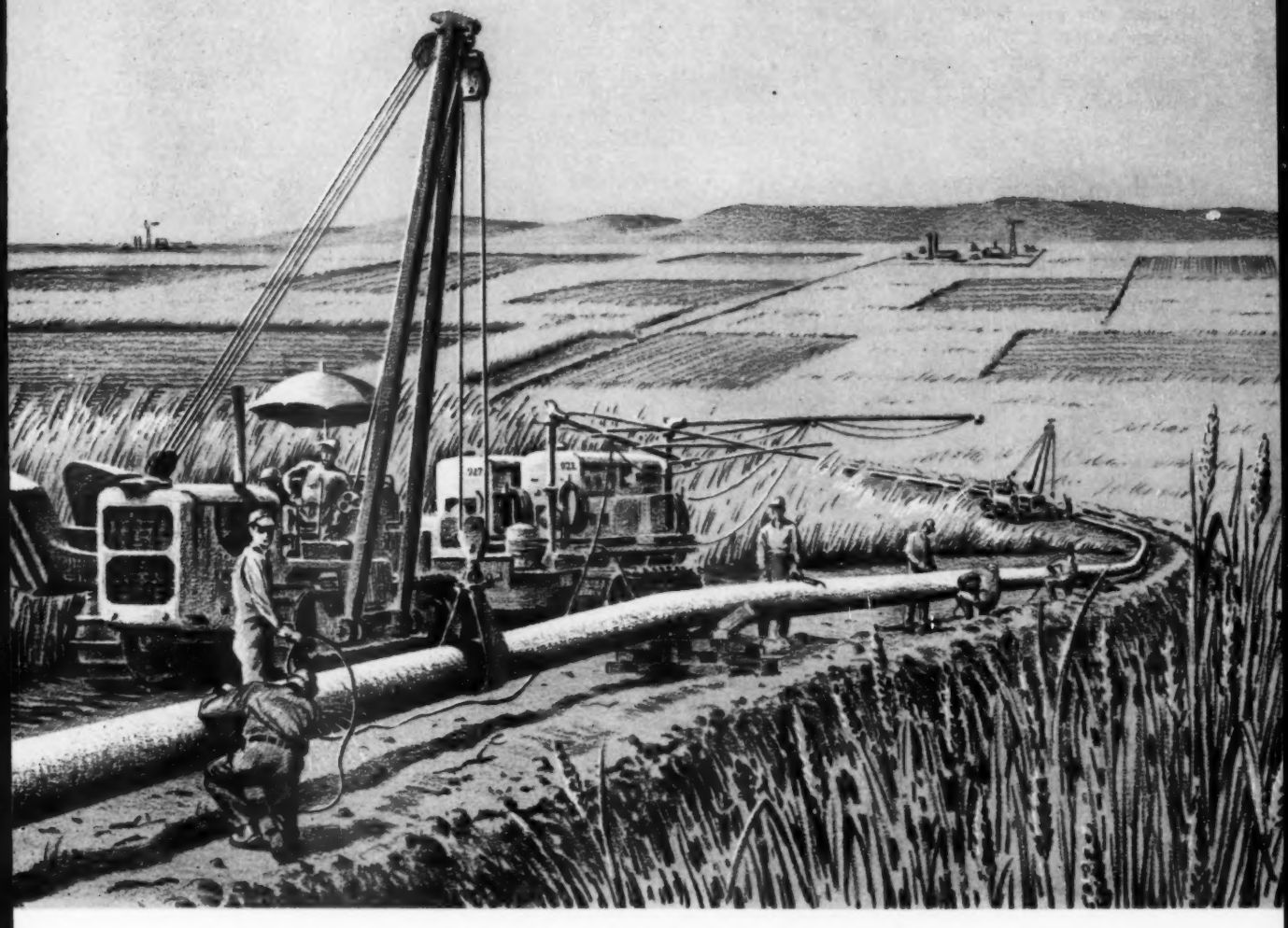
Abandonment request denied

The Federal Power Commission had adopted a presiding examiner's decision dismissing Deep South Oil Co.'s request to abandon sales of natural gas to Texas Gas Corp. Sales are made from the North Big Hill field in Jefferson county, Texas.

In its exceptions to the examiner's decision, Deep South claimed it is confronted with a financial emergency because of its present inability to market enough gas to get a satisfactory return on its investment.

FPC said evidence supports the examiner's denial of the request. The Natural Gas Act permits discontinuance of service only if the available gas supply is depleted or the present or future public interest will permit it. Exhaustion or depletion of Deep South's dedicated gas reserves has neither been shown nor alleged, FPC said.

Beneath The Spring Wheat Lies an Even Richer Harvest



Hundreds of miles of pipelines gathering this "harvest" of oil and gas in the Northern Great Plains are built with Stupp Corporation *high-yield strength, lightwall steel line pipe.* And now even more pipeliners are specifying Stupp Corporation *custom-manufactured* pipe—they know it means faster, easier and safer handling, improved bendability and weldability, and *major all-around economies* at highest industry standards. Sizes range from 6⅝ through 16 inches. New longer lengths (up to 64 feet) mean *up to 34 fewer field welds per mile.* Call, write or wire Stupp Corporation for a quotation on *your* next job . . . wherever it is.

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Transco plans underground storage

Transcontinental Gas Pipe Line Corp. plans to spend about $26 million to acquire and develop new storage facilities to increase its storage capacity for the New York area by 250 MMcfd.

President E. Clyde McGraw said that negotiations have been completed with United Natural Gas Co. for joint development of the Wharton gas field in northern Pennsylvania. Transco's share in the development will provide 18 MMcf of storage annually. When completed, it will raise Transco's daily capacity available from storage during winter months to over 700 MMcf.

Northern, Mich.-Wis. plans approved

Northern Natural Gas Co. can increase its system sales capacity by over 174 MMcfd. FPC approved Northern's plan to spend some $37.5 million on the project.

The decision includes authorization for Northern to sell 75 MMcf of the increase to Michigan Wisconsin Pipe Line Co., which also received authorization to spend $6.5 million on facilities to transport the new gas supply.

Northern's expansion program was covered in three separate filings. Involved are sales to existing customers in Wisconsin, Illinois, Michigan, Iowa, Minnesota, Nebraska and South Dakota.

Michigan Wisconsin will sell the new gas to existing customers in Michigan, Wisconsin, and Iowa. Three of these customers—Milwaukee Gas Light Co., Wisconsin Power & Light Co., and Madison Gas & Electric Co.—will serve several communities in central Wisconsin for the first time.

Involved in Northern's construction: some 380 miles of pipeline and 20,600 hp in compressor stations.

Michigan Wisconsin plans to build about 88 miles of line and 3000 hp in compressor capacity.

FPC reopens MRF's allocation hearings

FPC has reopened proceedings involving the allocation of Mississippi River Fuel Corp.'s gas pipeline capacity.

In September 1960, an FPC presiding examiner ordered *pro rata* increases in the stated demands of all Mississippi's utility customers, whether or not they were parties to the proceedings. The action allocated virtually all of MRF's present system capacity.

Then, on Jan. 10, 1961, MRF asked FPC to reopen the proceedings because "changes of fact have occurred since the conclusion of the hearings which are of compelling materiality."

Mississippi contends that the basic issue involved is the adequacy of natural gas to meet the needs of its utility customers. A pipeline being built by its subsidiary, Mississippi River Transmission Corp., will bring a new gas supply into the area and completely destroy the gas shortage. MRF also contends that future storage plans and changes in the demands of other customers will eliminate any possible shortages.

Efficiency boosted

Cities Service Gas Co., Oklahoma City, plans to build, replace, and operate facilities that will increase efficiency of its system in Kansas and Missouri.

Included in the plans: 8.5 miles of 20-in. loop on its Ottawa-Sedalia-Carrollton 12-in. line; 8 miles of 16-in. replacement line on its Springfield 10-incher; replacing 5 miles of its 4-in. Neosho line with 8-in.; and replacing about 2.5 miles of its 12- and 16-in. Range line with 16-in.

Construction is under way on a $6.2 million gas processing plant and sulfur recovery plant 25 miles west of Calgary, Alta. The plan will process 80 MMcfd of natural gas from the Wildcat Hills field.

United Gas Pipe Line Co. has awarded the pipe coating division of H. C. Price Co. a contract covering the coating of about 23 miles of 24- and 30-in. pipe.

FPC has issued Volume 19 and 20 of its reports, opinions, and decisions. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., is selling the volumes. No. 19, covering the first six months of 1958, sells for $4 per copy; No. 20, for the last six months of that year, sells for $3.50.

Stockholders of Midwest Piping Co. Inc. approved the sale of substantially all of their assets to Crane Co., Chicago. Crane plans to continue the present management and sales policies of Midwest under the direction of O. P. Carter, president of Midwest since 1958. The company will be known as the Midwest Piping Division, Crane Co.

Tennessee Gas Pipeline Co. has ordered a new Solar gas turbine-driven centrifugal compressor. The unit, driven by a Solar T-1000 engine, will be installed at Tennessee's Leeville, La., compressor station.

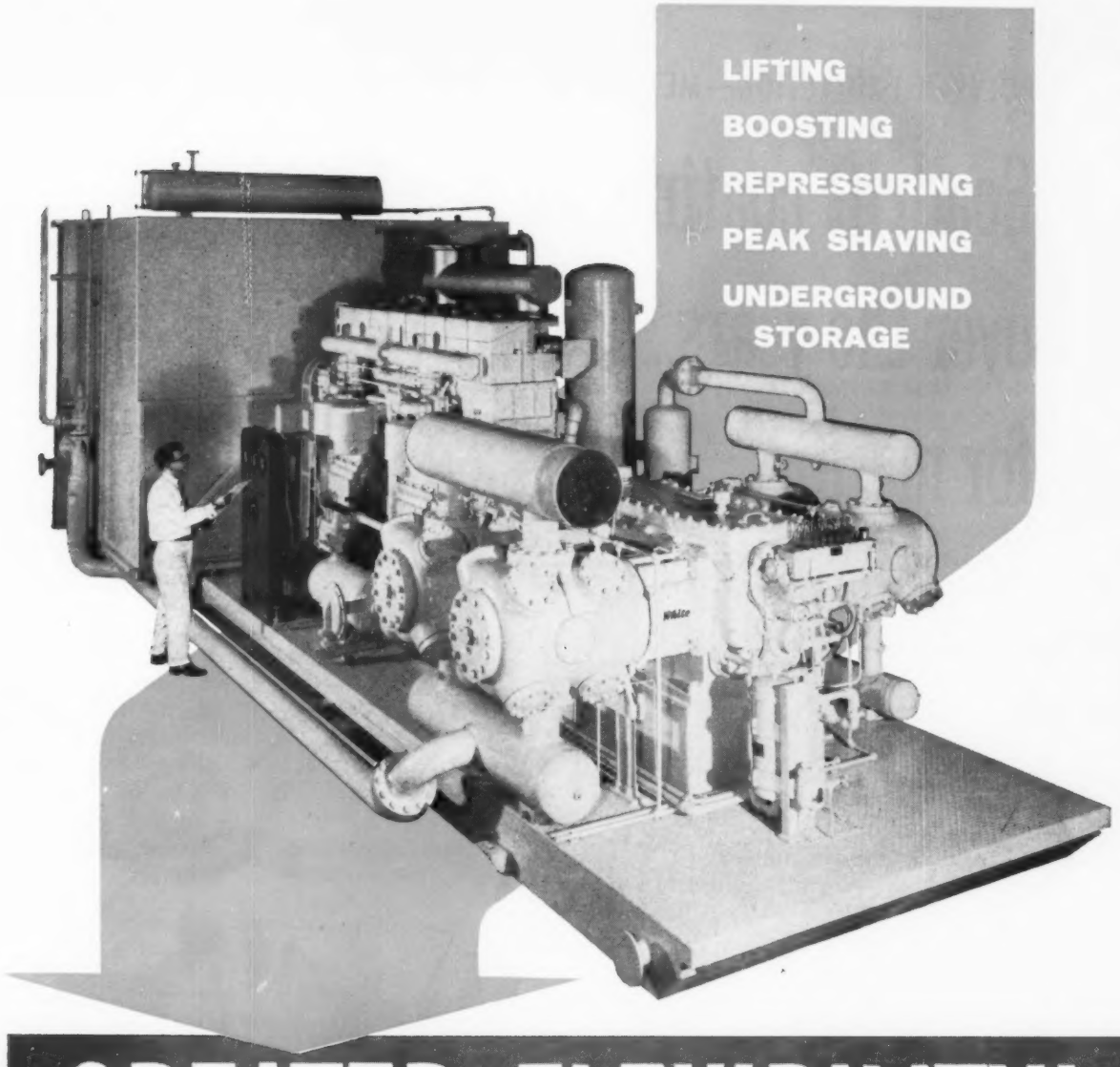
Pipe Line Service Corp. has opened a new 94,000-sq ft pipe coating and wrapping plant in North Lima, Ohio. The plant has a capacity of 2500 carloads of pipe per year. This is the second company plant offering plastic pipe coatings in addition to the traditional company line of bituminous tar compound coatings.

Lone Star Gas Co. is boosting compression and processing facilities at its Gordon gasoline plant in Palo Pinto county, Texas. The $850,000 project includes a 2000-hp compressor and a dehydration unit. During 1961, this station will compress about 65 MMcfd of gas.

Sales of natural gas and its derivatives should be contributing more than $270 million annually to the Canadian economy by 1965, according to British American Oil Co. president E. D. Loughney. He said that 1965 industry sales, estimated at more than 530,000 bbl per day, would have a heat energy equivalent to 530,000 bbl per day of crude oil. This is almost exactly the amount of Canada's total production of crude oil and natural gas liquids during 1960. By 1965, gas exports to the United States are expected to increase to nearly six times the 1960 level.

American Natural Gas Co. has moved its New York offices to 30 Rockefeller Plaza.

Stupp Corp., Baton Rouge, recently honored its 192 local employees who had worked 520 days without a lost-time accident. Executive vice president Kenneth S. Bayless presented each employee with a travel clock to commemorate the occasion.



GREATER FLEXIBILITY!

WHITE-SUPERIOR 200/1000 BHP COMPRESSORS offer broad flexibility for gas company applications. They are specifically engineered for direct drive combination with medium speed Superior gas engines or electric motors and provide optimum combinations of piston speed, horsepower and service life.

Two, four and six-cylinder models offer cylinder sizes from 4000 psi, 2⅝" dia. to 85 psi, 22½" dia. providing 68 different standard cylinders. Custom sizes and designs are available.

These continuous, heavy-duty units also provide wide speed range, manual or fully automated station operation, and they can be block mounted or skidded and unitized to facilitate moves for service changes. Get complete information now . . . write for Bulletin 124. White Diesel Engine Division, Springfield, Ohio.

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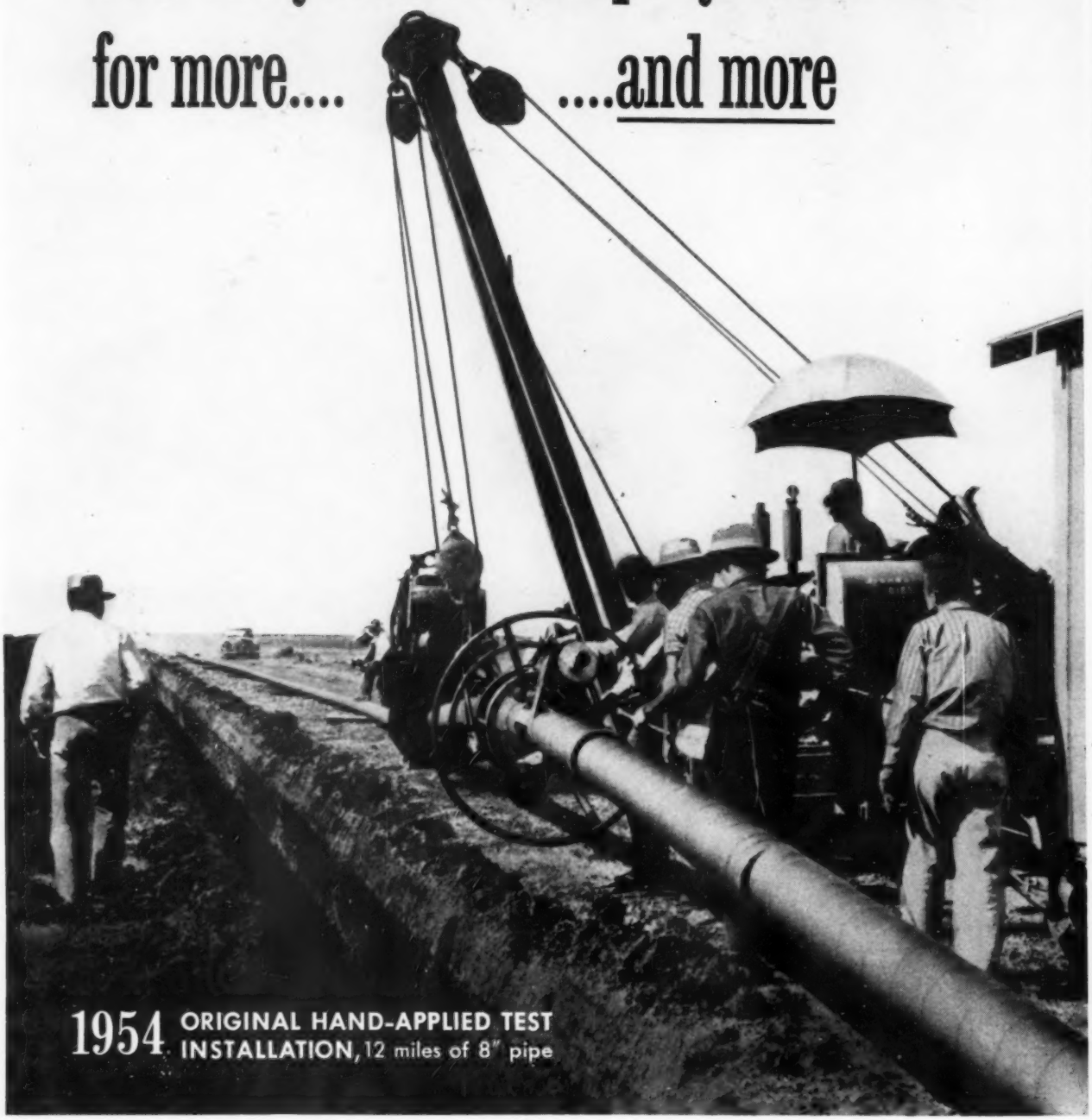
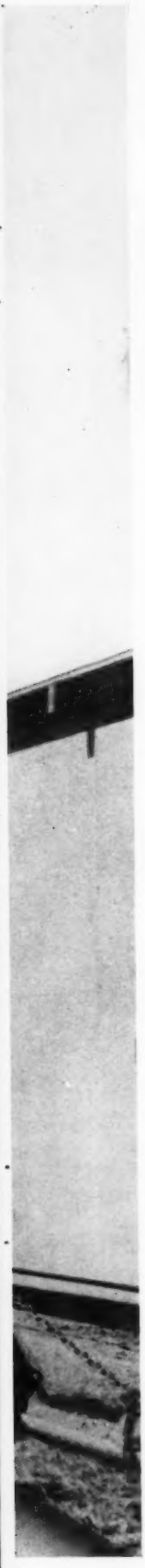
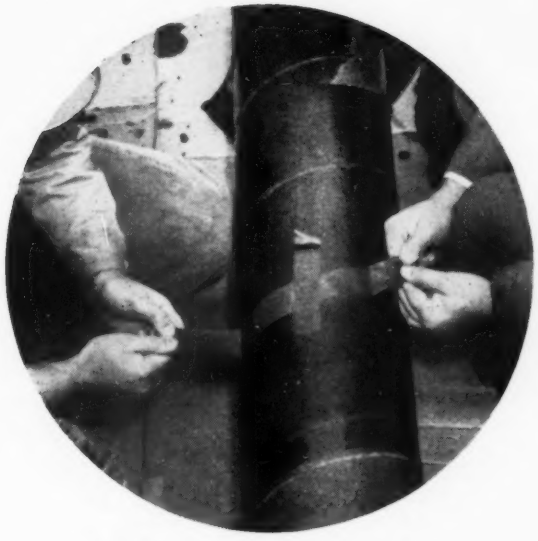


1954 ORIGINAL HAND-APPLIED TEST INSTALLATION, 12 miles of 8" pipe





Bell hole examination convinces second firm, too, to make important use of Polyken protection!

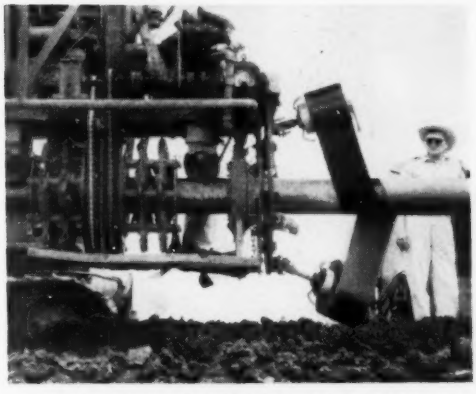
Proof of dependable performance . . . most graphic endorsement of Polyken. Case in point: In 1954, Seadrift Pipeline Co. set up a test installation of 12 miles of 8″ gas pipeline from Bee County to Seadrift, Texas, wrapped with Polyken #900 Black. Its fine performance through subsequent years, as demonstrated by very satisfactory cathodic protection requirements and the absence of corrosion, made Polyken the choice again for the company's line from Live Oak County to Seadrift (31 miles of 6″) in 1957.

Then, in 1960, continuing good cathodic protection results, confirmed by a bell hole examination of the original 8″ job, proved Polyken tape still in *top-rated* condition after 6 years. No rust or corrosion on pipe. Tape itself showed no sign of time-wear or deterioration.

These jobs were labeled "very successful installations". With all this evidence at hand, Seadrift officials again put Polyken protection to work on their 1960 projects—more than 300 miles of 6″ and 8″. And engineers from another major pipeline company, present at the above bell hole inspection, developed their own conviction of the durable protection of Polyken on the basis of this 6-year experience. They ordered this *proven performance* coating for an important part of their new products line in Iowa.

The key to these decisions is performance—proven performance. That's why the growing list of Polyken users includes some of America's most exacting firms. Get the full details on Polyken performance and economy from your Polyken representative, or write Polyken Sales Division, 309 West Jackson Blvd., Chicago 6, Ill.

1957 ANOTHER SEADRIFT INSTALLATION, 31 miles of 6″ pipe



1960 STILL ANOTHER SEADRIFT INSTALLATION, more than 300 miles of 6″ and 8″ pipe

1960 ANOTHER MAJOR PRODUCTS PIPELINE INSTALLATION, on 8″ pipe

Polyken®

Experienced in modern PROTECTIVE COATINGS

THE KENDALL COMPANY
Polyken Sales Division

TEXANS SAY...

...it gets so hot in Texas that pipeliners just butt the pipe together and it welds itself. Or so they say.

The photo above was shot on a "cool" day in southwestern Texas. It was only 104°, not quite hot enough for "sun-welding." But the welders had the next best thing—easy-working Bethlehem electric resistance-weld pipe. It *always* takes a good weld. And it's made good and round, and with the proper bevel so that it will line up quickly.

ERW pipe in lengths up to 62 ft . . . sizes 5-9/16 to 16 in. OD

We make ERW line pipe in 62-ft lengths and in sizes from 5-9/16 to 16 in. OD. Meets API 5L, Grades A or B, or API 5LX, Grades X42, X46, or X52 specifications. Just like our continuous buttweld line pipe, it's made at our Sparrows Point, Md., plant, from where we ship it all over the world.

BETHLEHEM STEEL

It gets hot in Pa., too! The scene above is southeastern Pennsylvania in mid-summer, and the day was a real sizzler. The crew welding this Bethlehem 36-in. pipe appreciated even the scant shade of an umbrella.

EFW pipe in sizes 18 to 42 in. OD

Bethlehem makes electric fusion-weld, expanded line pipe from 18 in. up to 42-in. OD. What's more, we can make it with ¾-in. walls.

We make large-OD, high-test line pipe in 40-ft. lengths, meeting all applicable API standards and lined at the mill if desired. We can also produce fabricated pipe to the above sizes using high-strength, alloy steel to achieve the desired physical properties with relatively thin walls. Substantial savings are possible.

For good, sound line pipe for any kind of pipeline, check with Bethlehem. Our nearest sales office can give you all the details.

Steel

for Strength
. . . Economy
. . . Versatility

BETHLEHEM STEEL

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Export Sales: Bethlehem Steel Export Corporation

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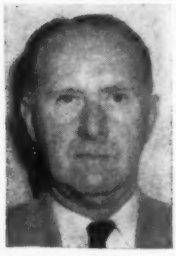
Lone Star

L. B. Thaxton
Lone Star



J. C. Bolender
North Shore

GAS·PEOPLE

A. W. Breeland
Lone Star

H. G. Dillin
San Diego

H. G. DILLIN was elected president of San Diego (Calif.) Gas & Electric Co. by the board of directors. Dillin, who has been serving as executive vice president, succeeds E. D. SHERWIN, who retired from the post of president after 41 years with the company. Sherwin will continue as a member of the board of directors and of the executive committee.

A. W. BREELAND AND CHARLES G. BARNDT are new vice presidents of Lone Star Gas Co., Dallas. L. B. THAXTON was elected treasurer. Breeland, vice president, personnel, and Thaxton succeed WILLARD G. WIEGEL, who retired in April. Barndt, formerly director of promotion, was elected to the new post of vice president, promotion. Breeland was former assistant personnel director and Thaxton was assistant treasurer.

JOHN C. BOLENDER joins North Shore Gas Co., Waukegan, Ill., as manager of operations.

HARRY L. LEPAPE joined Southern Counties Gas Co., Los Angeles, as assistant counsel.

VINCENT FARNSWORTH JR. was elected assistant president of Boston (Mass.) Gas Co. In addition to his present duties as treasurer, assistant secretary and assistant clerk, he will be in charge of the company's customer contact division, customer accounting - data processing division, and financial division. WILLARD C. WOLFF was elected vice president, responsible for sales. He succeeds J. J. QUINN who has been vice president in charge of sales since 1947. Quinn will continue as vice president in general administrative capacities until his retirement in October. JOSE DE VARON, assistant secretary and assistant clerk of the company, has been named assistant general counsel.

ROBERT G. BASHORE joins Peoples Natural Gas Co., Pittsburgh, as assistant manager of area development.

New appointments at Bucyrus-Erie Co., South Milwaukee, Wis., include ROBERT L. SMITH, manager of sales promotion; HOWARD FREYENSEE, general products sales manager; and ROBERT P. BROOKS, large machine sales manager.

C. L. NEAVES named administrative assistant to JOE C. DARROW, Lone Star Gas Co.'s vice president in charge of distribution. Neaves succeeds F. L. RICHARDSON who retired recently.

A. NEWELL ROBB has been promoted from domestic sales manager to sales manager of Portland (Maine) Gas Light Co.

ORBIE BOSTICK promoted to manager of commercial and industrial sales for Atlanta (Ga.) Gas Light Co. Succeeding Bostick as chief industrial engineer is F. RICHMOND CHADWICK JR., formerly industrial engineer in the company's Macon division. G. F. EDWARDS is manager of the company's Atlanta division.

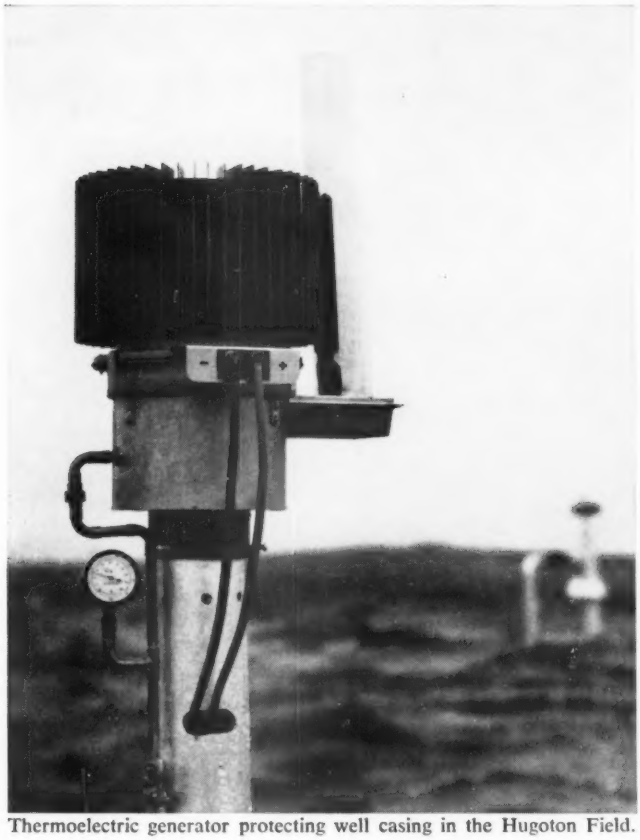
Southern Cross Corp., Atlanta, Ga., is the corporate outgrowth of Southern Cross Foresters, with JAMES J. CHAISSON having purchased his former partner's interest. Chaisson is president of the newly formed company; R. MAYES PIERCE, with Southern Cross for more than 10 years, is vice president in charge of operations; and DOROTHY M. WALLACE is secretary-treasurer.

DUDLEY E. HEATH and EDWARD R. GILMORE have been elected vice presidents of Arkla Air Conditioning Corp. Heath has been serving as staff coordinator of the Arkla plant at Evansville, Ind. Gilmore is vice president of Arkla's Meter Division at Russellville, Ark., where he is also general manager.

JOHN H. MILLER, former senior industrial sales engineer, has been named manager of the new architects department in the sales division of Peoples Gas Light & Coke Co., Chicago.

EDWARD F. WATSON is division plant superintendent, Paterson (N. J.) Gas plant and T. LAURENCE POWERS is safety engineer, gas department, general office, Public Service Electric & Gas Co., Newark, N. J.

CARL H. SIMON, executive vice president and general manager of Darling Valve & Manufacturing Co., Williamsport, Pa., has been elected to the board of directors of the American Standards Association for a three-year term.



Thermoelectric generator protecting well casing in the Hugoton Field.

Again, CPS Is In There Fustest With The Mostest . . .

in the form of a field tested thermoelectric generator which is in production and available at moderate cost

As a result of the joint design and development efforts of Texas Instruments, Incorporated and Cathodic Protection Service over the past year we are happy to announce to the corrosion engineer the availability of a field-tested and proven thermoelectric generator. This unit described herein is not a laboratory model or a prototype but is a unit which is now in commercial production and is ready for practical applications of cathodic protection in the field.

This generator which has no moving parts produces currents from lead telluride thermocouples which convert heat directly to electric energy. This, the "guts" of the unit, has gone through extensive shakedown tests in the Texas Instruments laboratories for the better part of the developmental period.

The lead telluride system is built into a housing consisting primarily of a burner capable of using either natural gas or LPG as the fuel and an efficient heat dispensing unit. The complete production model of the generator has been exhaustively tested both in our shops and in an actual field installation providing current for the cathodic protection of a well casing.

To be assured of continuous operation under all types of climatic conditions in the field the burner for the production line model has been designed to withstand wind velocities in excess of 100 mph by actual test.

First attention has been given to the development of a unit of 8 watts capacity, a rating capable of covering a large number of cathodic protection applications, particularly in the field of protection of well casings. This is the unit which is in large scale production but represents only the first of a series of generators which will meet nearly all cathodic protection applications. Additional capacities will be anounced in the near future.

The present production model is particularly suitable for the protection of well casings of moderate current requirements, extensive hot spots on bare gas pipe lines, and also for furnishing supplemental power for the protection of coated pipe lines and heater treaters or other salt water handling equipment, just to name a few of the potential applications for this commercially available unit.

CPS is the sole outlet for this jointly developed unit as applied to the cathodic protection field. Contact our main office in Houston or any of the below-listed branch offices for operating data and cost information.

Cathodic Protection Service
P. O. Box 66387 Houston 6, Texas JA 6-1981

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5425 Andrews Hwy. EMerson 6-6731

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BEND

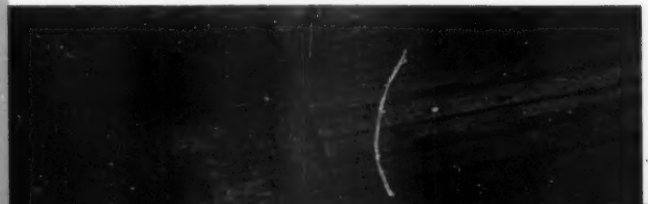
When you measure performance by the cost per mile, count on line pipe from Youngstown

Work with Youngstown line pipe in the field. String it. Bend it. Cut it. Weld it. Lay it. See how round and straight it is. Watch how it hugs each contour. Line pipe from Youngstown is made to deliver all the characteristics and trouble-free performance that makes your low cost system a far better one.

All Youngstown electric weld line pipe 12¾" O.D. and over is hydrostatically expanded. Brute power of water pressure works the metal, expands it, strengthens it. Each length is given roundness and straightness. Result . . . better welding and bending qualities. And on all Youngstown line pipe, precision tests and quality controls assure the high standards of performance you demand.

Order Youngstown electric weld line pipe in sizes 6⅝" through 22" O.D. Name your coating, if you need one. Order it in faster-laying lengths averaging over 50'. Get fast delivery where and when you want it, through Youngstown District offices, or through 900 independent pipe distributors. For transmission, distribution or gathering systems, always specify line pipe from modern Youngstown, the world's second largest producer of quality pipe.

Youngstown – growing force in steel



For full details on Youngstown Electric Weld Line Pipe, write, Dept.18-A,
The Youngstown Sheet and Tube Company, Youngstown, Ohio

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John Emery
Rio Grande

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George Clayton
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R. M. Grogan
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F. C. Eggerstedt
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Grove

Rio Grande Valley Gas Co., Brownsville, Texas has elected the following officers: WILLIAM B. WOOD, general superintendent since 1957, vice president in charge of transmission and distribution operations; JOHN T. ASHFORD, manager of production, vice president in charge of production and gas development and also elected a director. ROBERT T. MCMINN assistant treasurer, was elected assistant treasurer and assistant secretary; JOHN EMORY was promoted from assistant to general superintendent of the company. PAUL O. KOESTER of Mineral Wells, Texas, was also elected to the board of directors.

E. L. BRUCE named sales manager at Johnson - Williams Inc., Palo Alto, Calif.

Long Island Lighting Co., Mineola, N. Y., elected RUSSELL M. GROGAN as vice president in charge of the office of production, transmission, and construction. Senior Attorney CHARLES R. PIERCE was elected assistant secretary; FRED C. EGGERSTEDT JR., vice president in charge of finance, was elected treasurer and will hold both titles.

THOMAS O. CARSON named assistant vice president, meter and valve division sales, for Rockwell Manufacturing Co., Pittsburgh. Succeeding Carson as regional manager, central region, is D. H. SHOEMAKER, Pittsburgh district manager since 1957.

GEORGE H. CLAYTON was named to the newly created post of director, new construction marketing, for Southern Counties Gas Co., Los Angeles. Replacing Clayton as San Gabriel Valley division sales manager is W. D. SIMONSEN. WAYNE NELSON succeeds Simonsen as division sales manager in the Santa Barbara division. W. J. ALTPETER, who has been staff representative for builder promotion, moves up to Nelson's former post of staff representative for new construction.

EDGAR A. GAUDETTE joins Neptune Meter Co., New York, as assistant to the president.

JOHN W. CONYERS is western district sales manager of Pennsalt Chemicals Corp.'s new organic chemicals sales district on the West coast. Headquartered in San Mateo, Calif., the district initially comprises the states of Washington, Oregon, and California.

JOHN W. COLLINS has been named president of Grove Valve & Regulator Co., Oakland, Calif. With Grove for 18 years, Collins most recently was senior vice president and chief executive officer. Other appointments at Grove include ARNOLD H. STEPHENS named southern California district manager, Los Angeles. New sales engineers are FRANK F. ROSS, in Pittsburgh, and I. M. DEARING JR., in Lafayette, La.

HARRY S. JESKE, manager of the Koehring Southern plant at Chattanooga, Tenn., has been appointed president and general manager of Koehring's Kwik-Mix Div., Port Washington, Wis.

HAROLD B. CORNWELL has been named manager of Ohio Fuel Gas Co.'s eastern district, headquartered in Cambridge. He is succeeded as southeastern district manager, Athens, by DAVID E. YOUNG. DANE N. STEPHENS succeeds Young as Springfield division manager. RICHARD J. GORDON, Lake Erie district distribution engineer, is now Oberlin manager, succeeding DANIEL L. CRONIN, who has resigned. JAMES W. COLE, Bellaire division manager for Ohio Valley Gas Co., has been named Cambridge division manager for Ohio Fuel. RICHARD T. HESS goes from the Cambridge post with OFG to the Bellaire post with Ohio Valley.

MEDARDO M. MARTINEZ has been appointed company sales representative for Latin America by Ridge Tool Co., Elyria, Ohio.

Deaths

EARLE L. SIDES, 68, retired field supervisor for Metropolitan Utilities District, in Omaha.

S. MILLER WILLIAMS JR., 73, one of the founders of Wiliams Brothers Co., in Terre Haute, Ind., while on a business trip. In 1908 Williams and his brother, David, formed the construction firm which became a pioneer in building pipelines across the country and which accounted for more than 40,000 miles of the nation's pipeline network.

JAMES B. DOUGLAS, 82, former claims and insurance executive of Philadelphia (Pa.) Gas Works, in Swarthmore, Pa. For many years Douglas served as editor of PGW's monthly magazine. He was a pioneer in the industrial safety and first aid movements.

Are your costs too HIGH?

These pipeliners are cutting costs—using SIE control systems

DISPATCHERS CONSOLE used by Cherokee Pipe Line Company for automatic control of liquid line.

SIEMARC Supervisory Systems provide automatic monitoring and remote control for many industrial operations and processes including the petroleum installation pictured. Measuring, data gathering, telemetering, logging, display, indicating and computing are all integrated in the system. Both solid-state and relay components are used as dictated by proper engineering design. Transistors and semiconductor diodes are utilized in all high-speed switching and logic circuits including encoders, decoders, analog-to-digital converters, deviation detectors and magnetic drum circuitry. Separate electric logging typewriters record data and alarms.

POWER LEVEL CONTROLLER used by Shell Pipe Line Corp. Ozark System for maximum pumping station operating economy.

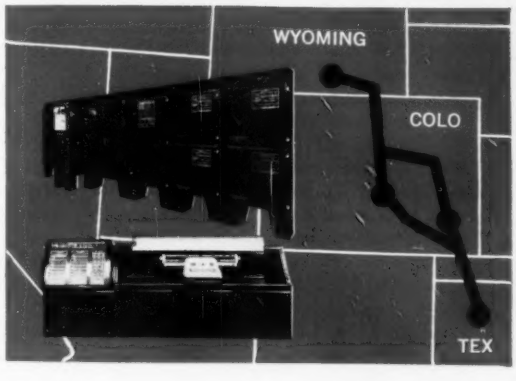
Completely unattended operation of a multi-unit pumping station is possible with Power Level Controllers used by Shell Pipe Line Corp. The unit accepts signals from flow and pressure pickups and makes logic decisions to bring proper combinations of pump units on or off stream automatically. It may be connected to the supervisory control system to permit reset of power levels from a central office dispatching console.

COMPRESSOR STATION CONTROL CONSOLE including complete engine control equipment for automatic station operation and safety.

For gas transmission automation, the basic SIEMARC system can be coupled with Log-Alarm Shutdown and Engine Control-Sequence units. Building block design throughout allows SIE to fit your needs exactly.

DISPATCH PANEL used by Colorado Interstate Gas Company.

In the Colorado Interstate Gas Company installation shown, dispatchers transmit only desired discharge pressure settings; automation at each compressor station responds by maintaining the selected value for optimum station economy. If communication links fail, local automation operates without interruption. Log-Alarm units insure station safety. Dispatchers are alerted only when trouble occurs.



Pioneers in solid state systems for supervisory control and telemetering.

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The first volume in a series on how SIE handles supervisory control and automation for the petroleum industry is now available. The booklet gives the ABC's of land line codes, binary techniques — and many more of the basics. A letter brings you "The ABC's of Industrial Telemetering."

W. D. Walser
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Trans-Canada

Donald Clark
Trans-Canada

George Woods
Trans-Canada

E. B. Blease
Northern

Pipeline People

H. M. Small
Blaw-Knox

Ralph Boyer
Cooper

W. D. WALSER has been promoted to senior vice president of Tennessee Gas Transmission Co., Houston. With TGT for 15 years, Walser has served as corporate secretary, controller and, since 1954, vice president. Elected to a vice presidency was JAMES E. IVINS, corporate secretary since 1952 and senior attorney since 1958. He continues as senior attorney. Elected vice presidents were WALTER FAWCETT, GILBERT FITZGERALD, and LEONARD F. LEE. Fawcett was director of gas contracts, Fitzgerald was assistant controller, and Lee was manager of the company's office in Washington, where he will continue to serve. HULETTE F. ABY was elected corporate secretary, succeeding Ivins, and additionally was promoted from associate general attorney to general attorney.

JAMES W. KERR, president and chief executive officer of Trans-Canada Pipe Lines Ltd., Toronto, was also elected chairman of the board. GEORGE W. WOODS was named vice president and treasurer and DONALD G. CLARK became vice president, sales.

Changes in personnel have resulted from the reorganization of the accounting division of Natural Gas Pipeline Co. of America, Chicago. Two new divisions — data processing and disbursements, and accounting—report to N. L. MCCLURE, assistant comptroller. R. E. HAYES is general superintendent and J. W. ALLEN is assistant general superintendent, data processing and disbursements division. M. M. SAIDIKOWSKI is general superintendent, accounting division. In the data processing and disbursements division, H. E. DUSOLD is superintendent, disbursements department; R. H. PRISCHING, superintendent, machine accounting; and L. W. ROBERTS, superintendent, routines and programs.

Four promotions were made in the management staff of the sales department of Axelson-Garrett, division of U. S. Industries Inc. J. P. NIELSEN advances to manager of product sales; J. T. CONNER remains as manager of product sales for gas lift, lease automation, wellhead safety systems and other related product lines. W. K. WOODWARD is manager of sales administration, supervising over-all material controls, sales engineering, and export sales. NEAL V. FOWLER is now manager of industrial sales. R. V. MCAFEE is manager of sales promotion and training.

HAROLD M. SMALL is division manager of the Buflovak Equipment division, Blaw-Knox Co., Buffalo, N. Y. He succeeds W. D. KOHLINS, who has resigned.

ERNEST B. BLEASE has been elected vice president of Northern Natural Gas Co., Omaha. He will head the newly created regulatory and forecasting division.

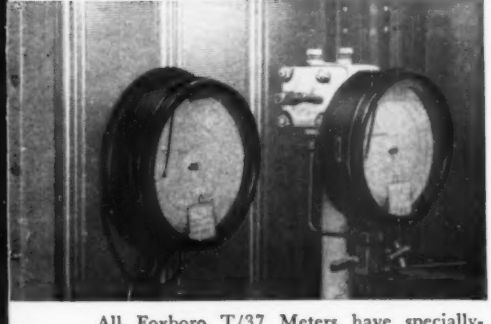
EDWIN C. YOUNG is product sales manager for mass flowmeters and Uniflux heating equipment, Black, Sivalls & Bryson Inc., Kansas City, Mo. RALPH E. STEVENS was named product sales manager for oil production equipment and J. E. BYERS, product sales manager for gas processing equipment.

RALPH L. BOYER, vice president and director of engineering for Cooper-Bessemer Corp., Mount Vernon, Ohio, has been named vice president of advance planning. In his new post, Boyer will devote full time to advance product planning. LESLIE R. GROVES, Lt. Gen., U. S. Army (Ret.), former head of the Manhattan Project which developed the atomic bomb, has been elected a director of Cooper-Bessemer.

NORMAN B. CHAMP JR. has been elected a vice president of Crane Co., Chicago. He will supervise the operations of the Midwest Piping division, St. Louis; Chapman Valve Manufacturing Co., Indian Orchard, Mass.; Swartwout division, Hookset, N. H.; and the Cochrane division, Philadelphia. Champ will headquarter in New York.

Transwestern Pipeline Company uses Foxboro T/37 "dry" meter and temperature recorder to log gas purchased from Parsell Field, Texas, well.

wet gas, line surges, the weather... nothing upsets Foxboro "dry" flow meters



All Foxboro T/37 Meters have specially-formed diaphragm discs with solid metal spacer rings. Diaphragm assembly can't be damaged by overrange, line surges, or winter freeze-ups.

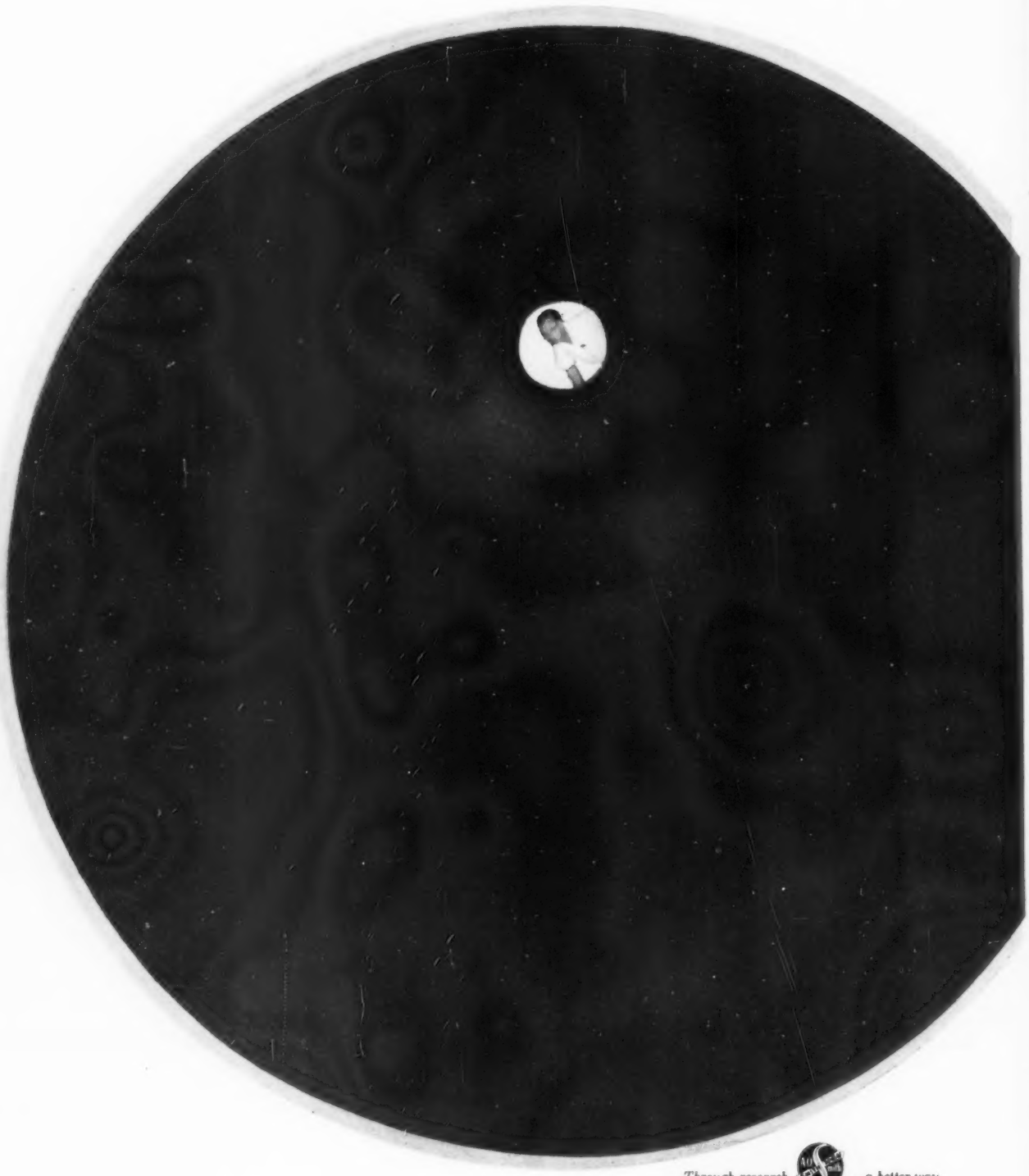
You'll find Foxboro T/37 Flow Meters on gas wells and gathering lines all over the Texas Panhandle... including many of those owned by Transwestern Pipeline Company—America's newest supplier of natural gas.

Since Panhandle gas normally contains a high amount of liquid hydrocarbons, the T/37 is a "natural." There is no mercury to clean or replace. Maintenance is kept to a minimum. In addition the T/37 is completely free from zero drift and ambient temperature effects . . . resulting in the highest sustained accuracy of gas flow measurement.

No wonder both pipeliners and producers are high in their praise for the Foxboro T/37. Mercury-less—accurate—almost indestructible, it's the flow meter that's setting new standards for gas measurement. Ask your Foxboro Field Engineer for complete details. Or write for Bulletin 7-15. The Foxboro Company, 346 Norfolk St., Foxboro, Massachusetts.

FOXBORO

REG. U.S. PAT. OFF.



Through research ...*a better way*

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CORPORATION

TUBULAR PRODUCTS DIVISION
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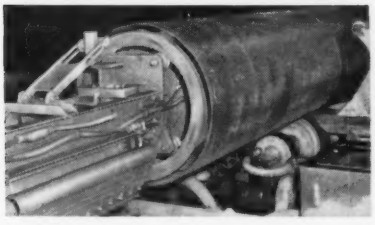
PICKLING—All plate for A. O. Smith pipe is pickled to remove rust and mild scale. The clean surface is preserved throughout the complete pipe-making process.

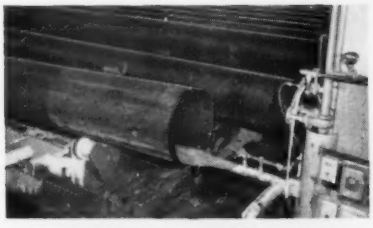


CLEANING — Wire brushing and scrubbing with a hot cleaning solution is the first step in the preparation of pipe for internal coating.

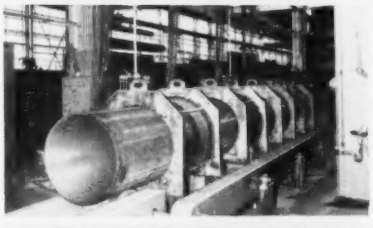
internal coating "a better way"

A. O. Smith Corporation believes that the best coating results are obtained from an originally clean, pickled surface, and that coating applied to such a surface will yield maximum benefits to the user. To this end A. O. Smith has established newly designed and fully enclosed facilities for *separate* cleaning and *separate* coating of 16″ through 36″ line pipe at both its Houston and Milwaukee plants.

These modern coating facilities are typical of A. O. Smith's ability to manufacture line pipe to exact customer specifications. For your exact coating requirements, contact the A. O. Smith sales office near you.

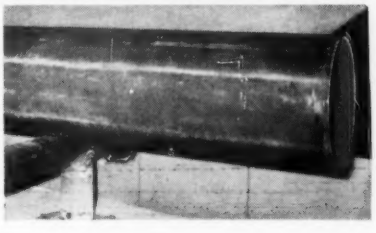


FLUSHING — Rotating pipe is thoroughly flushed with clean, hot water, leaving a clean, bright surface.



HEATING — Pipe is heated to a controlled level prior to the application of the internal coating.

SPRAYING — Airless spray equipment is used to apply the coating in a vented, dust-free enclosure.



CURING — Residual heat accelerates curing before pipe is exposed to weather.

Any trend toward streamlining the measurement function within the operations of the control center mechanism would be consistent with the indication that the control center is being charged with the overall direction of the pipeline operation. Automation of compressor stations of the various systems terminates in the control office and from here emulate the signals that result in activation of the stations. It is visualized in most automated facilities under study that the control center will be the "hub" of the activity. Therefore, the transmission of flow data from *all* primary measurement points on the system would be consistent with existing policies.

A measurement facility that was under remote supervision and which transmitted electronic signals of its operations would also be susceptible to receiving instructions for "feedback" control, thus permitting flow or pressure control of the station. It is not difficult to stretch this concept to supervision and control of field well stations.

PIEA-PESA Meeting

HAVING just returned from the PIEA-PESA annual convention and exhibition in Galveston, Texas, and the Southwestern Gas Measurement Short Course in Norman, Okla., I had the opportunity to view the following items which would be of value in any system utilizing remote measurement:

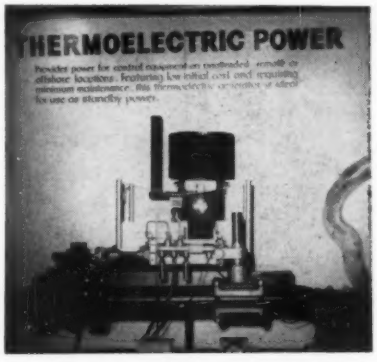
(1) The Daniel Orifice Fitting Co.'s Multiplex fitting whereby any one of five orifice plates may be placed in the line by remote switching. The Daniel Duomatic orifice fitting also lends itself to automatic gas measurement. (SWGMSC)

(2) Rotron Controls Corp.'s gas flowmeter using the "vortex-velocity" principle. (SWGMSC)

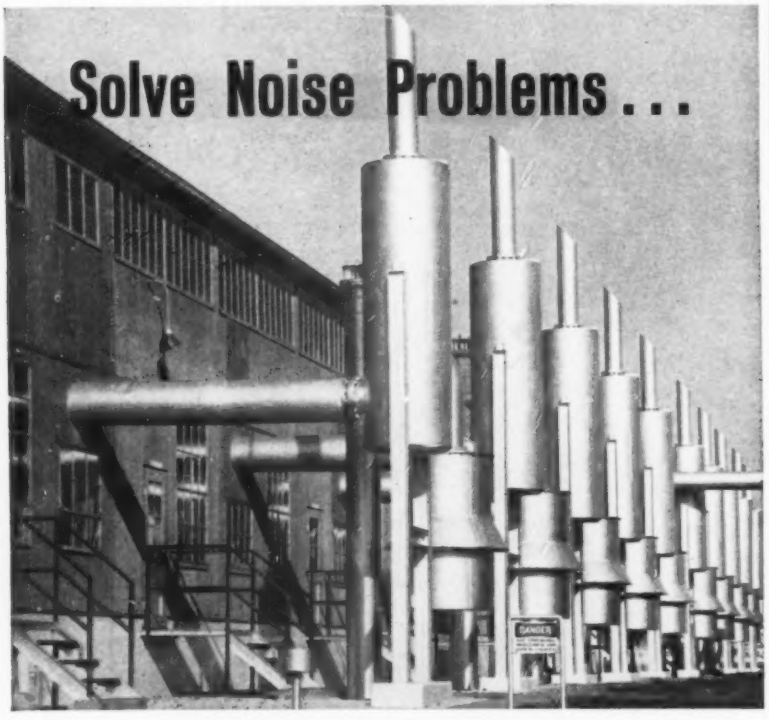
(3) Mullins Manufacturing Co.'s Dial-O-Graph automatic chart changer which would permit retaining a chart record of the flow characteristics for producer or customer verification. (SWGMSC)

(4) The Foxboro Co. exhibited its telemetering system for measurement and computation of gas flow information wherein the percentage of full station capacity utilization is transmitted to the control center. (PESA)

(5) Texas Instruments displayed its thermoelectric generator that



Texas Instrument's thermoelectric generator.



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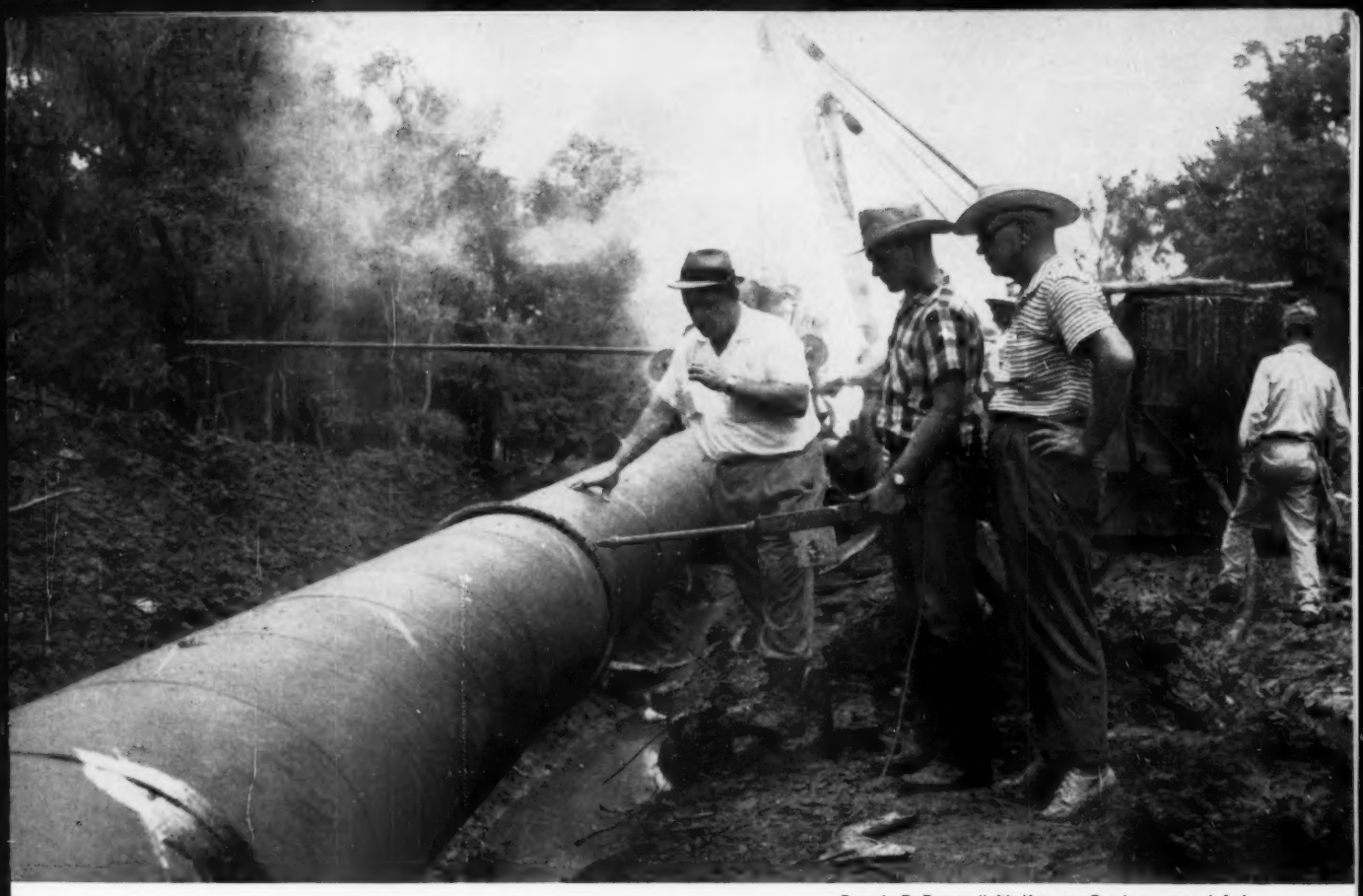

Francis DeRouen (left), Koppers Serviceman, and A. L. Eubanks, Inspector for Ford, Bacon & Davis, Monroe, Louisiana, watch "jeep" test on finished coating job.

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"A thorough background of experience is extremely important on pipeline jobs, and Koppers Serviceman DeRouen has plenty of it," says Mr. A. L. Eubanks, Spread Inspector for Ford, Bacon & Davis, the engineering firm that designed and supervised the installation of Old Ocean Fuel Company's 24-inch gas line to Ft. Worth and Graham.

"Francis DeRouen's 26 years of experience with protective coatings helped us solve some knotty application problems on this job," Mr. Eubanks continued. "He helped us get the maximum corrosion protection with Bitumastic enamels on the really tough parts of the line, where heavy, wet gumbo places severe stresses on the pipe. We appreciated his services and our coating foreman profited from his advice."

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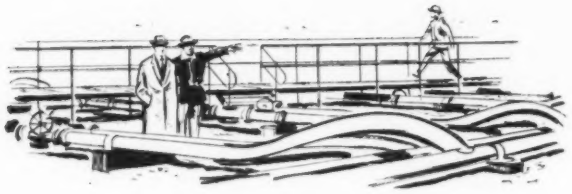
will produce 8 watts of power with an input of 3 cu ft of gas per hour. This power may be used to furnish requirements for remote operations at an outlying location. (PESA)

In conclusion

I would appreciate receiving the reaction of those actively engaged in the measurement of natural gas regarding this subject and its possible effect on future measurement. Your inquiry or comment on any phase of measurement-automation or control will be welcomed and it is to be hoped that this column in the future will incorporate topics of genuine interest to persons working in the measurement-automation-control field. ■



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communications • *Cont'd.*

from page 127

brought about the situation of which it complains. Western Union is asking the Commission to restore a "status quo" which would ignore both the public demand for a common carrier service to provide a flexible and economical means of handling bulk communications and the competition of private microwave systems. But the Telpak tariff is lawfully in effect, private microwave competition is a reality, and the 'status quo" cannot be restored.'

"The telegraph company's assertions, AT&T said, 'reveal that Western Union's alleged inability to offer a service to the public which will effectively compete with either private microwave systems or Telpak is the result of its own business decisions. There is no attempt to explain how restricting AT&T's efforts to compete with private microwave systems would enable Western Union to become competitive in the field.'

"The telephone company said there is 'no basis' for complaint against the Telpak tariff by Western Union, nor 'for the arbitrary restrictions it seeks to have imposed.'

"Regarding Western Union's 'suspicion' that Telpak rate levels are 'open to question,' AT&T declared that it 'certainly does not warrant a formal investigation. The Telpak rate structure is presently under investigation by the Commission staff, and full and detailed cost support has been furnished to the Commission.' "

Whatever happens, it appears that the gas industry's rapidly climbing communication needs will be adequately met. ■

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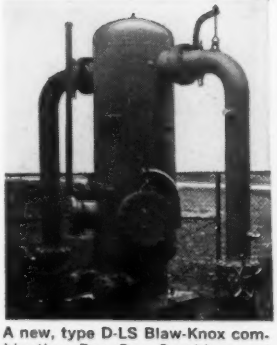
We would like you to know more about our new Scrubbers. Write for Catalog No. 394—or ask for our representative to call. Buflovak Equipment Division, Blaw-Knox Company, 1547 Fillmore Avenue, Buffalo 5, New York.



A new, type D-LS Blaw-Knox combination Dry Gas Scrubber and liquid separator installed at a town border station in Ohio.

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GAS convention coverage

continued from page 102

tions of the coupling—one each on driver and driven shafts—was explored, and test results presented. Shape and hardness of the elastic members are controlled to produce any torsional stiffness required by the drive.

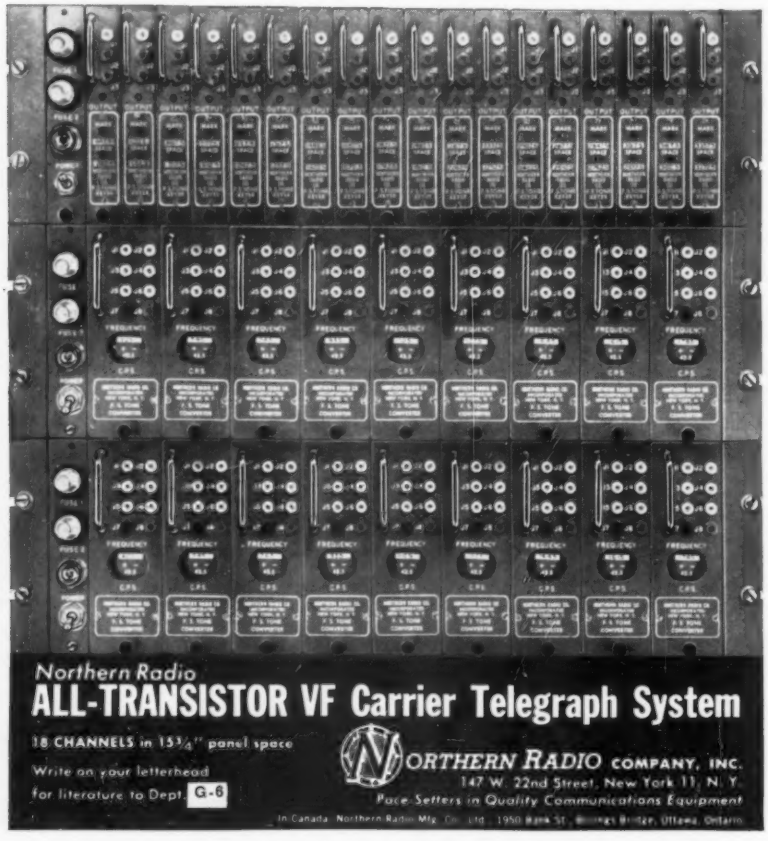
It is interesting to note that in the history of the development of the engines used in this installation, the rated BMEP has doubled within the past 15 years. As a result the energy input contributed by the fourth-order harmonic has increased by some 55 per cent. As engine designs continue toward higher horsepower and improved efficiency, the need for careful torsional analysis will assume an increasingly important part in the application of internal combustion engines.

"Operation and Maintenance of Metallic Rod Packings for Reciprocating Compressors," was the subject of a paper by Gilbert Wilkes III, California district manager, France Packing Co. He stressed the higher speeds, pressures, and temperatures which today's reciprocating compressor must work against, while handling a variety of gases not dreamed of 20 years ago. In addition to the technological advances in metallic rod packing design resulting from these stepped-up service requirements, the need for more precise installation, run-in, and maintenance techniques has arisen. The author stressed the concept of preventive, or as it has been termed, "progressive" maintenance, with its attendant emphasis on operating economies in terms of the cost of down-time and unscheduled overhauls, has resulted in advances in materials development and application technology of metallic rod packings.

Dr. Martin A. Elliott, director, Institute of Gas Technology, discussed "Fuels in the Future" at the Monday afternoon session. Confining his studies to continental United States, Dr. Elliott surveyed present consumption of fossil fuels, and on the basis of known reserves and a graduated scale of recovery costs, outlined the trend of fuel consumption for the next 140 years. Population growth is also forecast, as energy consumption is based primarily on the requirements of the individual.

Processes are available for converting coal and oil shales to liquid fuels. On the basis of economic analyses of conditions existing in the United States, it is provable that liquid fuels will be produced from oil shale only; this has been assumed in the present analysis. High Btu gas may be produced from either coal or oil shale, and processes for accomplishing this are undergoing intensive development. To simplify the analysis, it has been assumed that all gas required to supplement natural gas will be produced from coal.

On the basis of these assumptions, and with all energy supplied only by domestic fossil fuels and hydropower, our total resources of coal are adequate for considerably more than 100 years. However, toward the middle of the next century it probably will be necessary to start production of coal at 1.25 to 1.5 times present costs. Oil shale resources are also adequate for the next 100 years, but it may be necessary to convert some of the lower grades of shale into liquid fuel.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Leo T. Brinson Jr., assistant chief engineer, Nordberg Manufacturing Co., discussed "Cycle Analysis from Combustion Equations." He presented a method of evaluating the scavenging efficiency of a two-stroke cycle diesel engine based solely on data obtained from the engine under test. Incidental data from a single-cylinder engine is included only for the purpose of demonstrating the validity of the procedure, and the quality of the results which can be achieved. Comparison of test-engine thermal efficiency with the theoretical thermal efficiency shows good correlation through the use of a "diagram factor" which is substantially constant for a given engine.

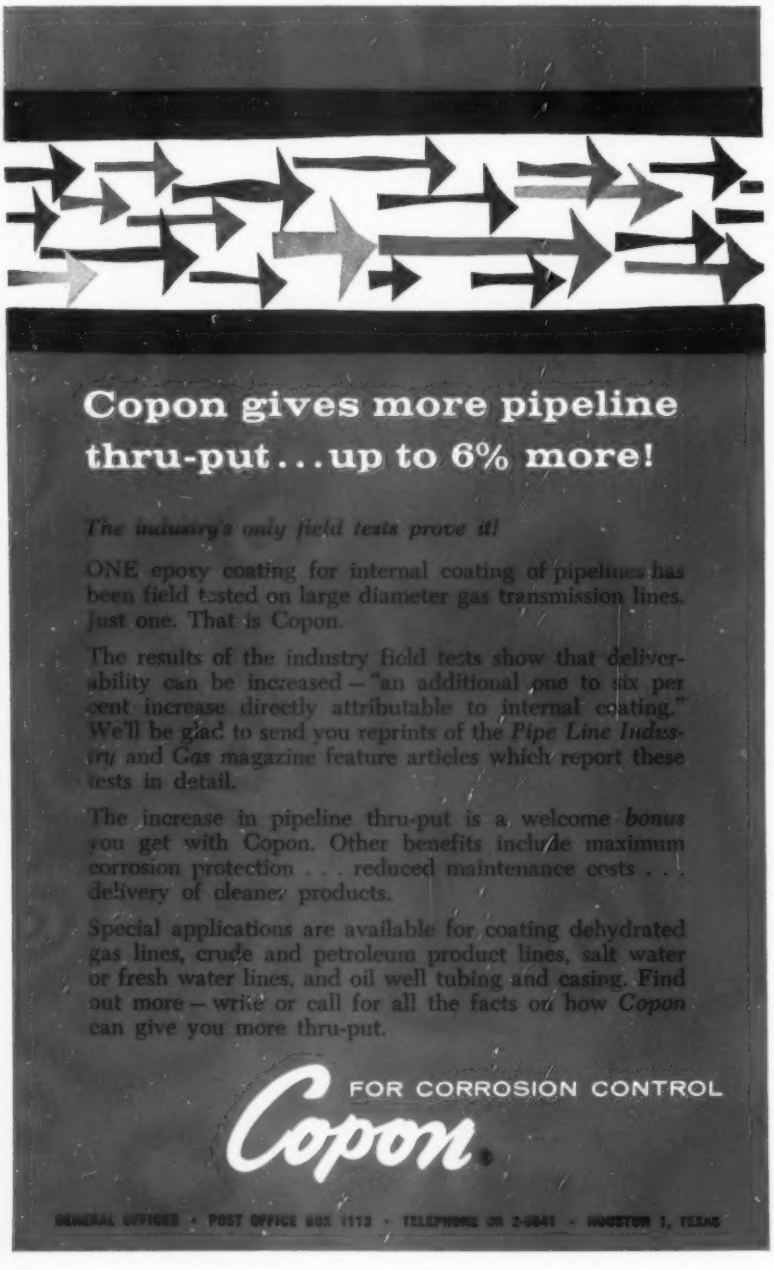
"Turbocharger Selection, Matching and Development for Two-Cycle, Spark Ignition Gas Engines," by W. H. Payne, manager, reciprocating research and engineering department; George H. Bollman, project engineer; and Robert L. Johnson, head, experimental and development department, all of Clark Bros. Co., was presented by the last-named author.

He presented the conditions a turbocharger must meet to satisfy a given engine's requirements; and stated the characteristics of the turbocharger components and performance, such as flow, head and efficiency, which are necessary for use with a two-cycle, spark-ignited gas engine. The authors used graphs to show the operating characteristics of a turbocharger compressor and turbine, and these were used to discuss the matching of the turbocharger to the engine. Development problems were discussed relating to altitude applications, and the shifting of one blower's and turbine's flow capacities to meet several engine requirements. Applications of turbochargers to various mounting locations were described as were various turbochargers developed by Clark.

On Wednesday afternoon, B. G. Golden, chief field engineer, Burgess-Manning Co., discussed wave phenomena and conditioning of induced air and exhaust gas in the operation of internal-combustion engines. He projected pulsation and its effect upon cylinder scavenging and engine performance by a simple mechanical analogy. Optimum conditioning of wave phenomena and noise (relevant to the operation of an internal-combustion engine) by the "snubber" principle was enumerated through analytical and empirical reasoning.

J. M. A. Van Der Horst, president, Van Der Horst Corp. of America, with W. A. Schultze, technical vice president of Lemet Chromium N. V., discussed electrochemical cylinder corrosion. The problem investigated was the possible presence of an electrolytic cell composed of piston, combustion products, and cylinder. For the investigation the piston was insulated, a flexible electrical connection installed from piston to an oscilloscope and from there to the cylinder. In this manner difference in potential between piston and cylinder could be determined at every position of the piston.

Burning a 2.5 per cent sulfur fuel (heavy fuel) after 40 minutes operating under load, a potential difference indicated the presence of an electrolyte. Investigation showed the electrolyte was localized in the upper portion of the cylinder, and was composed of sulfuric acid and water. With chrome-liner and cast iron rings, corrosion was evident. When cast iron cylinder and rings of the same material were used, no cell was evident. Use of alkaline lubricants solves the corrosion problem, but these are high in cost compared with straight run oil. It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W. M. May, Freeburg Station Superintendent, and K. W. Robertson, Gas Engineer of Illinois Power, discuss recent expansion of Freeburg Station. Its four 700hp Cooper-Bessemer FM Compressors pump 36,000 mcf/day at 65 psi suction and 260 psi discharge.

Illinois Power reports...

How to keep pressure up when demand goes up

To meet growing gas demands and maintain pressures, Illinois Power Company is expanding its underground storage and its compression facilities. It is now building a new storage station and has just completed additions to two compressor stations.

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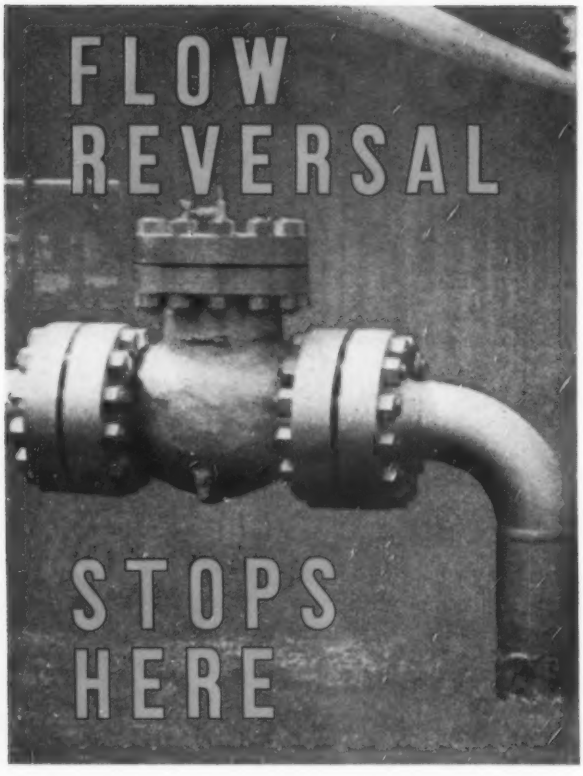

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is the author's conclusion that very low rates of cylinder wear can be attained in large diesel engines operating on heavy fuel when: (1) chrome-plated liners, (2) chrome with channel-like porosity, (3) properly designed oil grooves, and (4) tailor-made emulsion lubrication are adhered to.

The final session of the meeting concentrated on automation and control problems. R. D. Hamilton, assistant manager, En-Tronic Controls division, Cooper-Bessemer Corp., described the complete automation achieved at Nantucket Gas & Electric. He outlined the design philosophy and details of that system to answer the question: What is necessary for complete automation of a diesel utility?

Complicating this installation are three different-sized engines and the handling of residual fuel. The pushbutton was eliminated and the entire station operated unattended for a good part of each day. The utility effected a manpower reduction through natural attrition of personnel leaving the job or retiring.

Ralph G. Abbott, assistant manager, engineering, American Bosch Arma Corp., discussed "Automatic Gaseous Fuel Controls." He explained a novel regulating device for changing automatically the gaseous fuel supply for a spark-ignition engine from an intermittently available low-cost, or waste, gas to a higher Btu standby gas until the low-cost waste gas is again available.

C. R. Carmichael, sales manager, Amot Controls Corp., summarized current trends in engine control application. He presented several basic system philosophies and illustrated these trends by analyzing major design considerations as well as operational and economic features.

Summarizing, he said that interest in automatic and remote control is very high in those fields of industry where operation ultimately permits such practice. Yet the complication of controls systems proceeds at a rather deliberate pace, which arouses the suspicion that attainment of optimum control is more desired than complexity for its own sake. He believes that properly designed system with adequate safety features will return over their lifetime far more than their original cost and upkeep.

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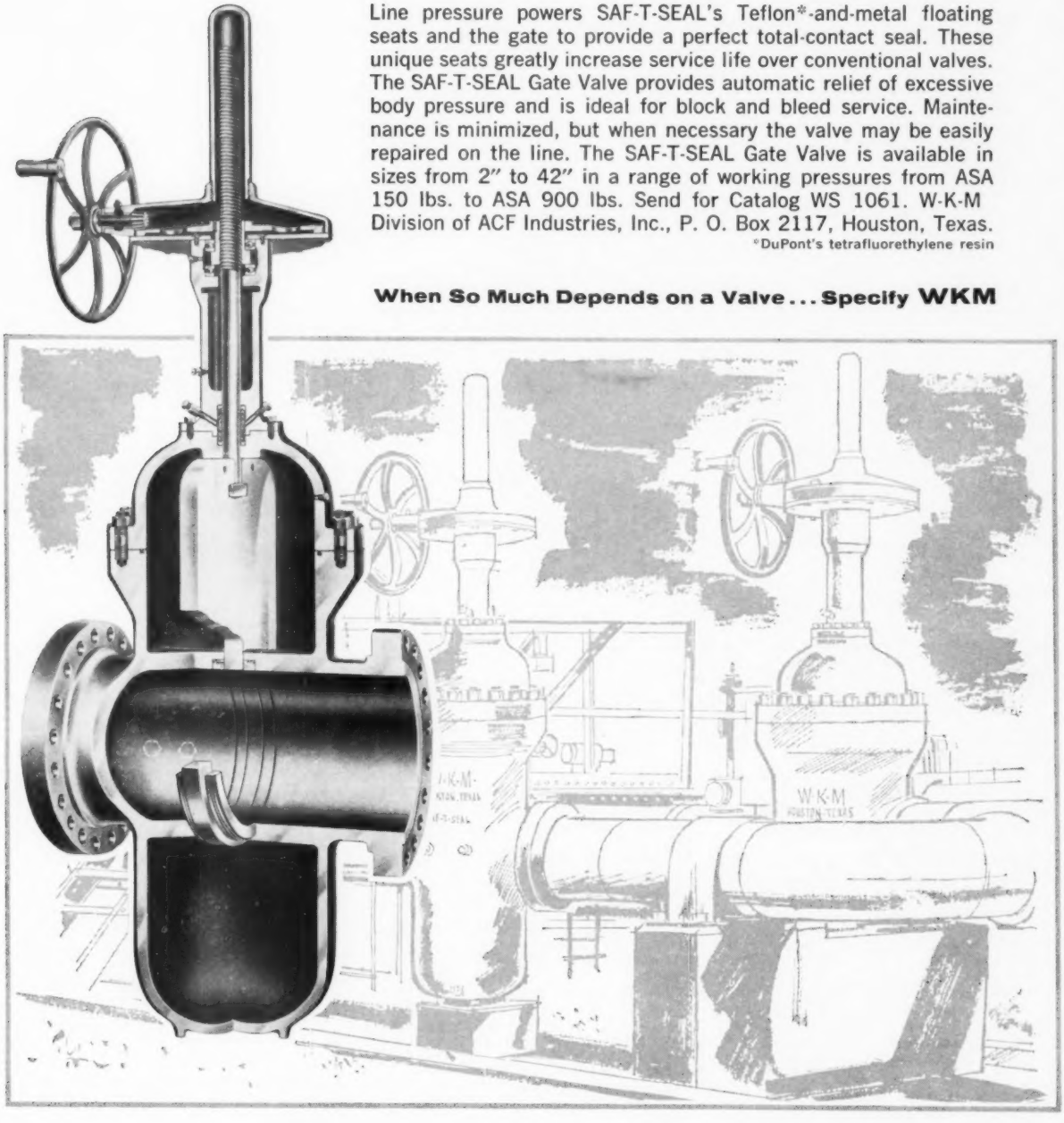

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ACF Industries Inc., W-K-M Div. 157
Acme-Newport Steel Co. 14
Adams Pipe Repair Products —
American Cast Iron Pipe Co. —
American Meter Co. Front Cover, 98, 102
American Meter Co., Reliance Regulator Div. Second Cover
American Systems, Inc. 90
Anderson Co., V. D. —
Anderson & Grunsky, Inc. 90
Aqua Survey & Instrument Co. 100
Arcco Instrument Co., Inc. —
Arkla Air Conditioning Corp. 44
Armco Drainage & Metal Products Div. —
Arrow Manufacturing Co. —
Auburn Machine Works —

Babcock & Wilcox Co. 26
Barton Instrument Corp. 101
Baso, Inc. —
Beaird Co., Inc., J. B. 148
Bethlehem Steel Co. 136, 137
Bilco Co. —
Black, Sivalls & Bryson, Inc.—Third Cover
Blaw-Knox Co. 151
Bonded Products Inc. —
Bonney Forge & Tool Works —
Borg-Warner Corp.
Marbon Chemical Div. 33
Bristol Co. 46
Burgess-Manning Co. 5
Busada Supply Co., Inc. —

California Chemical Co., Oronite Div. 9
Cameron Iron Works, Inc. 121
Capitol Mfg. Co. —
Case Co., J. I. 47
Cast Iron Pipe Research Assn. 34, 35
Cathodic Protection Service 139
Chance Co., A. B. —
Chandler Engineering Co. 94
Chaplin-Fulton Mfg. Co. 16
Checker Motors Corp. 96
Chevrolet Motor Div., General Motors Corp. 30, 31, 54
Clark Bros. Co., Dresser Industries, Inc. —
Cleveland Trencher Co. 51
Cooper-Bessemer Corp. 155
Copon Associates 154
Corrosion Services, Inc. —

Daniel Orifice Fitting Co. 156
Deere & Co. —
Dollinger Corp. —
Dresser Industries, Inc.
Clark Bros. Co. —
Dresser Electronics, S.I.E. Div. 143
Dresser Manufacturing Div. 1
Roots-Connersville Blower Div. 32

Eastman Chemical Products —
Eclipse Fuel Engineering Co. —
Edwards Inc., Allan 152
Electro Rust-Proofing Corp. —
El Paso Natural Gas Co. 89
Empire Stove Co. —

Fenix & Scisson Inc. 100
Fisher Governor Co. 18, 19
Ford Motor Co.
Tractor & Implement Div. 83
Truck Div. 38, 39
Foxboro Co. 145

Gas Equipment Manufacturers —
General Motors Corp., Chevrolet Motor Div. 30, 31, 54
Goodrich Chemical Co., B. F. 10
Grobler Manufacturing Co. —
Grove Valve & Regulator Co. 24

Handley Industries, Inc. —
Hays Manufacturing Co. 102
Heath Survey Consultants, Inc. —
Hill Hubbell Co. —
Holan Corp. —
Homestead Valve Manufacturing Co. 27

Information Systems Inc. —
International Business Machines —

Jaeger Machine Co. —
Jay Co. Div., J. Leukart Machine Co. Inc. 96
Johns-Manville Corp. —
Johnson-Williams, Inc. —

Ka-Mo Tools Dept., Kwik-Mix Co. —
Koenig Iron Works, Inc. 100
Koppers Co., Inc.
Metal Products Div. 97
Tar Products Div. 149
Kralov/Chemtrol Co. 99
Kwik-Mix Co., Ka-Mo Tools Dept. —

Lancaster Meter Parts Co. 87, 95
Latex Construction Co. 150
Ledeen, Inc. 4
Leukart Machine Co. Inc., J., Jay Co. Div. 96
LimiTorque Corp. —
Lone Star Steel Co. 3

Maloney Co., F. H. —
Marbon Chemical Div., Borg-Warner Corp. 33
Marwais Manufacturing Co. —
Maxitrol Co. 92
McCabe-Powers Body Co. —
Midwest Piping Co., Inc. 153
Midwestern Pipeline Products Co. —
Minneapolis-Honeywell —
Minnesota Mining & Mfg. Co. —
Motec Industries Inc. 42, 43
Motorola Inc. 50
Mueller Co. 28, 29
Mullins Manufacturing Co. —

National Supply Co. —
National Tank Co. —
National Tube Div., U. S. Steel Corp. 129
Natural Gas Odorizing, Inc. —
Naugatuck Chemicals, U. S. Rubber Co. 36, 37
Nicolet Industries, Inc. 122
Nordstrom Valve Div., Rockwell Manufacturing Co. 13
North Electric Co. 126
Northern Radio Co. Inc. 152
Norton-McMurray Manufacturing Co. 88

Oil Center Tool Co. —
Oronite Div., California Chemical Co. 9

Parsons Co., Shawnee Dept. 98
Peerless Manufacturing Co. —
Pennsalt Chemicals, Inc. —
Perfex Plastics, Inc. —
Petroleum Instrument Co. —
Phelps Dodge Copper Products, Inc. —
Philadelphia Gear Corp. —
Phillips Chemical Co. —
Pipe Line Service Corp. —
Polyken Products Div., Kendall Co. 134, 135

Radiator Specialty Co. —
Radio Corp. of America 45
Rector Well Equipment Co. —
Reed Manufacturing Co. —
Reeves Bros., Inc., Vulcan Div. 53
Reliance Regulator Div., American Meter Co. Second Cover
Republic Steel Corp. —
Reynolds Gas Regulator Co., Inc. —
Ridge Tool Co. 91
Robertshaw-Fulton Controls Co. Thermostat Division —
Rockwell Manufacturing Co.
Gas Products Div. 21
Instrument Div. 41
Nordstrom Valve Div. 13
Rogers Brothers Corp. —
Roots-Connersville Blower Div. Dresser Industries, Inc. 32
Royston Laboratories, Inc. —

Safety Gas Main Stopper Co. 92
Security Valve Corp. —
Shawnee Dept., Parsons Co. 98
Skinner Co., M. B. 7
Smith Corp., A. O. 146, 147
Smith Manufacturing Co., A. P. —
Somerville Construction Co. —
Southern Cross Corp. —
Sprague Meter Co. Fourth Cover
Standard Pipeprotection, Inc. —
Stupp Corp. 131
Sun Shipbuilding & Dry Dock Co. —
Superior Meter Co. 22

Tapecoat Co. —
Tennessee Gas Transmission Co. 123
Tinker & Rasor 93
Transcontinental Gas Pipe Line Corp. —

UGC Instruments 124
U. S. Pipe & Foundry Co. 40
U. S. Rubber Co., Naugatuck Chemicals 36, 37
U. S. Steel Corp., National Tube Div. 129
Universal Controls Corp. —

Vermeer Manufacturing Co. 94
Vulcan Div., Reeves Bros., Inc. 53

Walworth Co. 92
White Motor Co.
White Diesel Engine Div. 133
White Truck Div. —
Wilcolator Co. 48, 49
Williams Pressure Service Co. —
Williamson, Inc., T. D. 104
W-K-M Div., ACF Industries, Inc. 157

Youngstown Sheet & Tube Co. 140, 141

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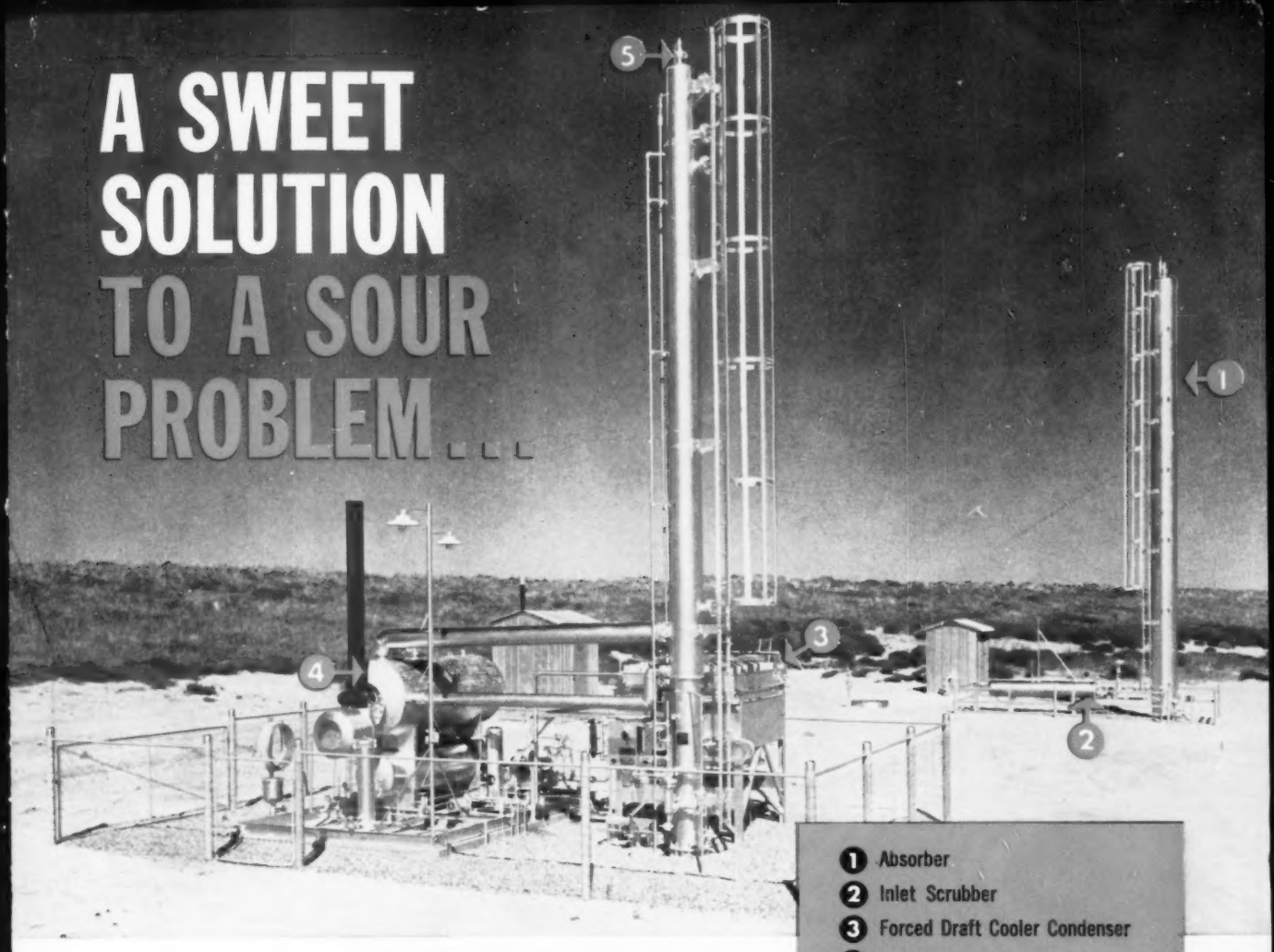

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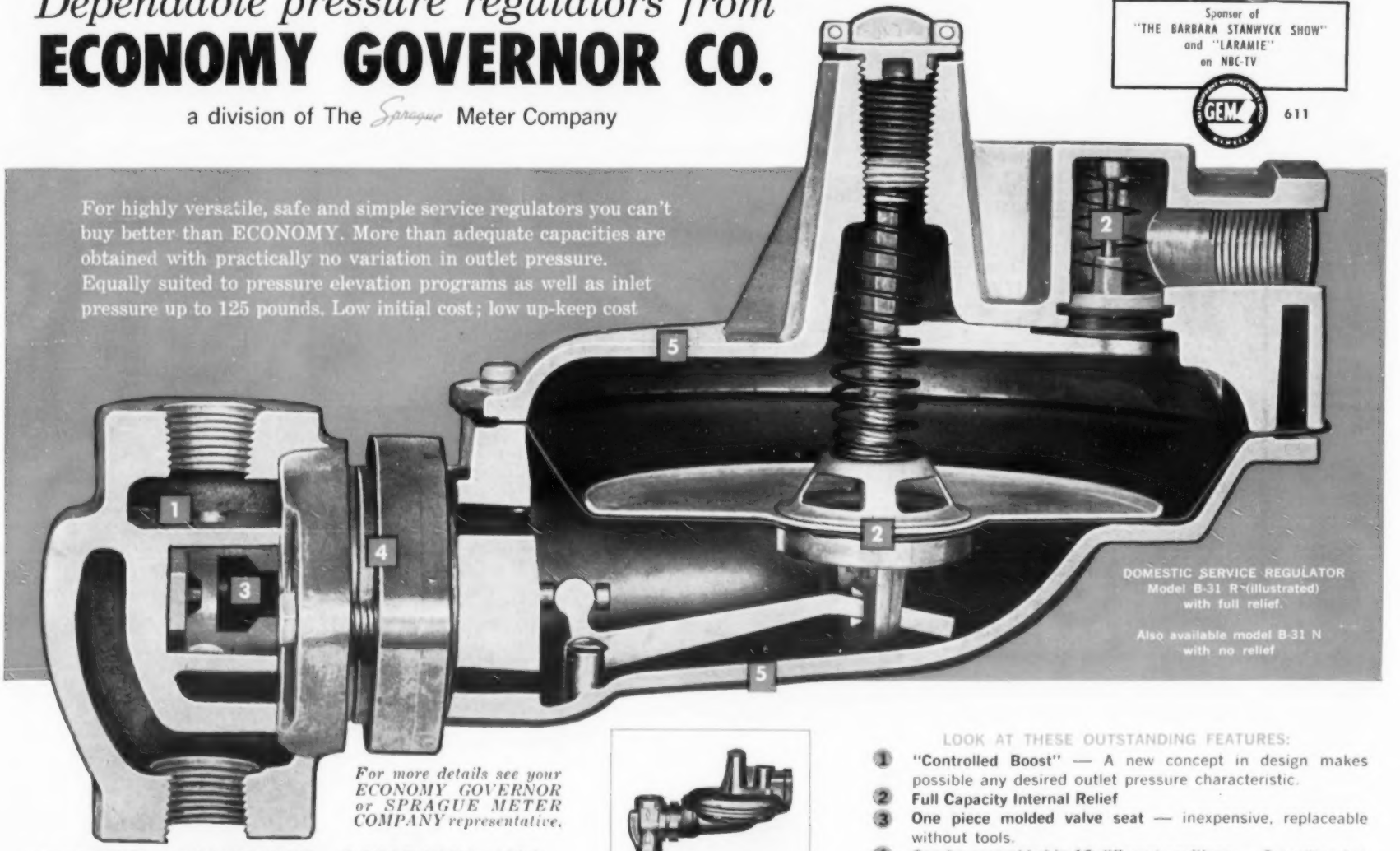

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